THE JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

VOLUME THE ELEVENTH.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1850.

These experiments, it is true, are not easy; still they are in the power of every thinking husbandman. He who accomplishes but one, of however limited application, and takes care to report it faithfully, advances the science, and, consequently, the practice of agriculture, and acquires thereby a right to the gratitude of his fellows, and of those who come after. To make many such is beyond the power of most individuals, and cannot be expected. The first care of all societies formed for the improvement of our science should be to prepare the forms of such experiments, and to distribute the execution of these among their members.

Von Thaer, *Principles of Agriculture*.

London: Printed by William Clowes and Sons, Stamford Street.

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DIRECTIONS TO BINDER.

The Binder is desired to place all the Appendix matter, with Roman numeral folios, at the *end* of the Journal, excepting Titles and Contents, which are in all cases to be placed at the *beginning* of the Part or Volume.

THE

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY

OF ENGLAND.

VOLUME THE ELEVENTH.

PART I.

PRACTICE WITH SCIENCE.

No. XXV.—1850.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

LONDON:—Printed by WILLIAM CLOWES and SONS, Stamford Street.

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CHART OF

THE ATLANTIC OCEAN

ON MERCATOR'S PROJECTION,

in illustration of an Essay on

THE CLIMATE OF THE BRITISH ISLES.

REFERENCES.

The Currents are shewn in Pink.

The Red Isothermal lines are from Humboldt. Those in Black are fixed by Doves Tables of Temperature.

The Figures on the Map shew the Temperature of the surface water of the Sea.

Gulf Stream
Mean Velocity 55 Nautical Miles 24 hours.

The observations on the Temperature of the Sea laid down on this Chart are from the following authorities.

Capt. Sabine in the Pheasant & Log Book of the Iphigenia Phil Mag May & June 1826.
Surveying Voyages of the Beagle Fitz Roy. Humboldts Voyages.
The Clyde Edin Phil Jour Oct 1845 observed at 8 A.M. Lawsons Voyage from Gibraltar to Barbadoes and to England Edin Phil Jour July 1845.
The Temperature of the Sea from the Faroe Islands to Greenland Edin Phil Jour No 90 1848.

M.T. Mean Temperature. The set of the Currents is shown by the arrows thus.

The Temperature of the surface water of the east side of the Atlantic as given below.

Mean	Water	Summer	Latitude
41 Faroe			62°N
54°	50°	58°	50°
62°	57°	67°	40°
70°	66°	74°	30°
74°	76°	78°	20°
78°			10°
81°			Equator

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*On the Climate of the British Islands in its Effect on Cultivation.* By Nicholas Whitley, Surveyor, Truro.

Prize Essay.

1. There are three primary elements necessary to the success of agricultural operations—skilful husbandry, a well constituted soil, and a genial climate. The first of these is now placed within the reach of every intelligent man, and depends on the application of his own skill and industry; the constitution of the soil is in general well adapted by nature for the functions it has to perform, and where it is defective, its composition may be corrected and its productive powers increased; but the elements which constitute climate appear to be beyond man's control; he is comparatively powerless to mitigate its rigour, or to add to its generous influence. It is man's master exacting submission, not his servant obeying his behests. Of what avail then, it may be asked, is the knowledge of such a subject? That we may bend to the power we cannot control, and learn to adapt our culture to the capabilities of the climate: indeed climate is the ruling principle of agriculture—the law which governs the productions of different countries, and he who yields the most enlightened obedience obtains the largest reward.

2. It is not necessary to compare the productions of equatorial regions, or of the shores of the Mediterranean, with those of our own country, to illustrate this law: the agricultural difference between the Highlands and Lowlands of Scotland—between the mountains of Wales and the eastern coast of England, afford equally instructive examples. The distribution of heat in these islands is most remarkable and anomalous; and the quantity of rain which falls on some districts, is six and even seven times greater than on others; these causes produce corresponding effects on agriculture, and therefore present a subject which claims a careful investigation from the cultivator of the soil.

3. I propose in this Essay *first to examine and determine the leading elements of climate, with regard to the British Isles; and then to apply the facts so established to agricultural operations and products.*

4. The atmosphere is the vehicle of climate, and it may be considered of the same composition in all parts of the world, affected only by the substances with which it comes in contact; thus imparting different degrees of heat and moisture to particular regions. Under ordinary circumstances the composition of 1000 parts of atmospheric air may be stated as follows:—

Oxygen	210
Nitrogen	775
Aqueous Vapour . .	14·2
Carbonic Acid . . .	·8
	1000

5. The temperature of the British Islands, and the distribution of heat through the year, claim our first attention. The amount of heat received by various countries is generally governed by their position with regard to the sun; the more direct the rays of heat fall on the ground, and the less of our vapoury atmosphere they pass through, the greater is their intensity and effect; but our own geographical position appears to be an anomaly in this respect: we lie between the same parallels of latitude as the ice-bound coast and winter stricken soil of Labrador, yet enjoy on our south-west shores almost a perpetual spring.

6. A correct view of the amount and distribution of heat can only be obtained from long and repeated observations in different places: these have to a considerable extent been made; but they are not always recorded in an available form, and are scattered through the reports and transactions of various societies. I have availed myself of such reports as were within my reach, extracts from others have been kindly forwarded to me from a distance; I have tabulated the monthly results, and extended the series through a period of ten years when it could be obtained. The valuable tables of temperature compiled by Professor Dove, and published in the Report of the British Association for the Advancement of Science, 1847, have afforded me material assistance. From these sources I have drawn the tables of temperature which accompany this Essay, rejecting such places as were superfluous, and endeavouring so to arrange the whole, that the variation of temperature for any month in the year may be traced from south to north, and from the equable climate of the Land's-end on the west, to the more unequal one of the eastern coast. (See Table I.)

TABLE I.—Showing the Mean Temperature of each Month,—of Summer,—and of the whole Year, at the Places mentioned.

Names of Places.	Lat. N.	Lon. W.	Elev. feet.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Sum. Temp.	Diff. of H. & C. Month.	No. of Years.	Hours of Observation.	Authorities.
ENGLAND.	° ′	° ′		°	°	°	°	°	°	°	°	°	°	°	°	°	°	°			
Penzance	50 8	5 30	..	42·62	44·90	45·32	48·07	54·55	59·52	62·10	61·11	57·11	53·36	47·54	45·16	51·78	60·91	19·48	21	8, 2 red.	Dove.
Helston	50 6	5 12	..	42·64	44·39	46·37	49·49	51·93	60·90	61·93	61·98	59·19	53·53	48·59	44·78	52·14	61·60	19·34	6	Daily extr.	Dove.
Truro	50 18	5 3	..	42·85	42·68	44·65	48·61	54·09	58·79	60·11	61·07	57·74	51·15	47·05	43·85	51·05	60·	18·39	10	Daily extr.	Roy. Inst. of Cornl.
Plymouth	50 22	4 6	..	44·61	44·83	45·60	48·53	54·92	58·88	62·01	61·80	57·78	52·72	48·15	45·14	52·078	60·89	17·40	5	Hourly.	Rep. Brit. Assoc.
Torquay (1848)	50 25	3 33	..	39·3	46·0	45·5	49·7	62·1	58·6	61·6	59·5	57·8	52·6	46·3	46·8	52·1	59 9	22·8	1	Daily extr.	Rep. of Reg.-Gen.
Exeter	50 43	3 30	..	40·97	41·10	43·45	48·33	54·95	59·90	61·15	61·10	57·30	51·	46·40	42·35	50·67	60·72	20·18	10	Daily extr.	Roy. Inst. of Cornl.
Sidmouth	50 41	3 13	..	36·3	42·	45·	51·	56·	61·	65·5	65·	61·5	53·	46·	43·	52·10	63·83	29·2	3	Daily extr.	Dove.
Isle of Wight	50 45	1 15	..	37·	41·	44·	46·	56·	62·	65·	62·	58·	51·	44·	39·	50·42	63·	28·	10	9	Dove.
Gosport	50 47	1 7	..	38·99	41·38	44·89	49·88	55·64	61·04	64·03	63·16	59·34	53·71	47·27	42·55	51·82	62·74	25·	16	Daily extr.	Dove.
Colchester	50 52	0 45	..	36·46	40·56	41·22	49·29	52·78	59·12	62·22	61·02	58·67	50·54	47·72	39·54	49·51	60·78	25·76	3	8, 8	Clark—Infl. of Cli.
Cobham	51 20	0 23	..	35·32	38·55	43·96	48·05	56·11	60·52	60·57	65·	57·51	47·17	43·17	38·75	49·55	62·03	29·14	3	Daily extr.	Roy. Inst. Rep.
Chiswick	51 29	0 18	..	37·17	38·02	41·87	47·39	54·77	60·59	62·27	61·81	56·16	49·27	43·56	38·42	49·44	61·55	25·10	10	Daily extr.	Phil. Mag.
London (Roy. Soc.)	..	..	..	37·2	40·1	42·5	46·9	53·5	58·7	62·4	62·1	57·5	50·7	44·	40·4	49·7	61·	25·2	65	Red.	Trans. Roy. Soc. 1849.
Greenwich	51 29	0 0	156	35·45	37·34	44·64	46·43	54·06	58·55	59·65	62·66	58·02	47·42	42·92	40·37	48·96	60·29	27·21	3	2 hourly	
Bristol	51 27	2 36	..	36·	40·	43·	51·	57·	61·	67·	65·	57·	49·	49·	45·	51·67	64·33	31·	1	..	Dove.
Swansea	51 36	3 53	..	42·	39·5	43·7	50·6	56·6	62·3	62·8	62·7	60·1	52·	45·8	40·4	51·05	62·60	23·3	5	Daily extr.	Rep. Brit. Ass. 1848.
High Wycombe	51 36	0 35	..	34·02	37·49	39·41	43·54	49·96	55·03	58·04	55·44	51·83	46·53	39·48	35·71	45·54	56·17	24·02	4	..	Dove.
Oxford	51 46	1 16	..	36·9	37·1	47·1	46·7	52·7	58·7	61·6	60·8	57·10	49·4	43·6	37·	48·64	60·37	24·7	2	10, 10	Dove.
Aylesbury	51 49	0 44	..	33·8	41·7	42·3	48·2	58·9	58·5	61·9	59·0	56·8	49·0	40·8	40·1	49·02	59·46	28·1	1	Daily extr.	Rep. of Reg.-Gen.
Cheltenham	51 54	2 4	..	38·25	41·75	46·18	50·50	54·16	61·50	66·33	65·12	59·06	50·32	43·50	41·75	51·54	64·32	28·08	3	Red.	Clark—Infl. of Cli.
Malvern	52 7	2 19	..	38·	40·8	35·3	39·5	49·8	58·4	61·8	59·8	54·5	51·5	42·3	41·2	47·	60·	23·80	1	Daily extr.	Dove.
Bedford	52 8	0 30	..	38·08	41·60	45·26	49·89	58·16	61·11	64·31	62·61	58·03	53·46	45·26	41·77	51·64	62·68	26·23	8	Daily extr.	Dove.
Southwick	52 30	−1 25	..	42·06	43·50	46·09	50·65	56·01	61·23	63·01	60·78	56·93	50·18	45·41	42·78	51·55	61·67	20·95	11	..	Dove.
Lyndon	52 32	−0 3	510	35·20	38·13	40·59	46·91	53·80	60·33	63·53	61·87	56·30	48·82	40·98	37·43	48·65	61·91	28·33	28	Daily extr.	Dove.
Norwich	52 37	−1 16	..	33·8	42·8	42·6	47·5	59·6	59·6	62·4	58·2	55·7	51·5	41·9	40·9	..	..	..	1	Daily extr.	Rep. of Reg.-Gen.
Derby	52 58	1 30	160	35·	40·5	40·	43·5	50·5	53·	55·5	54·5	51·	44·5	37·5	33·5	44·92	54·33	22·	2	..	Dove.
Boston	53 0	0 0	..	35·97	35·09	45·32	47·16	54·75	62·04	62·45	62·60	57·31	48·64	42·92	41·10	49·61	62·36	26·63	9	..	Phil. Mag.
Knutsford	53 20	2 20	..	35·77	37·98	40·63	45·06	50·86	56·23	57·96	57·36	54·21	47·66	42·39	36·62	46·89	57·18	22·19	10	8, 2, 10	Dove.
Liverpool	53 25	2 59	..	39·95	42·29	44·44	48·06	55·27	60·	61·41	62·	57·87	51·64	45·05	41·67	50·80	61·14	22·05	25	12	Dove.
Manchester	53 29	2 14	..	36·7	39·3	41·8	47·1	53·2	58·2	60·8	60·4	56·3	50·0	42·9	39·0	48·81	59·80	24·10	47	8, 1, 11	Dove.
Bolton	53 35	2 24	..	36·8	39·7	42·9	47·0	53·9	59·3	61·6	60·6	55·7	49·9	42·5	39·9	49·15	60·50	24·80	10	..	Dove.
Ackworth	53 39	1 20	..	35·73	38·18	41·60	45·85	51·70	57·92	60·72	59·51	54·95	49·47	41·79	39·86	48·11	59·38	24·99	18	Daily extr.	Dove.
York	53 57	1 5	..	33·39	39·01	42·91	48·20	57·01	61·18	62·42	63·51	57·26	47·81	40·81	36·43	49·16	62·37	30·12	3⅓	..	Athenæum, 1841.
Lancaster	54 3	2 48	..	36·55	38·07	37·22	44·27	51.15	55·74	57·71	57·05	54·24	47·31	40·30	36·62	46·36	56·82	21·16	7	10	Dove.
New Malton	54 8	0 47	85	35·27	37·	40·71	46·39	52·44	57·64	61·10	58·60	55·25	47·61	42·45	36·63	47·59	59·11	25·83	8⅓	Daily extr.	Dove.
Isle of Man	54 12	4 30	..	40·52	41·05	43·41	46·77	52·13	57·02	60·33	59·60	55·89	51·17	46·80	43·43	49·84	58·98	19·81	9	9, 11, red.	Dove.
Kendal	54 21	2 45	130	33·97	37·70	40·52	44·92	52.06	56·87	58·99	57·51	53·40	48·34	40·83	39·45	47·05	57·79	25·02	13	Daily extr.	Dove.
Seathwaite	..	..	..	34·80	34·82	40·65	41·63	52·27	58·07	64·80	58·46	50·97	46·61	45·30	39·20	47·46	..	30·	3	Daily extr.	Trans. of Roy. Soc.

To face page 2.

[*continued.*

TABLE I.—Showing the Mean Temperature of each Month,—of Summer,—and of the Whole Year, at the Places mentioned.—*Continued.*

Names of Places.	Lat. N.	Lon. W.	Elev. feet.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	Sum. Temp.	Diff. of H. & C. Month.	No. of Years.	Hours of Observation	Authorities.
ENGLAND. *(continued.)*	° ′	° ′		°	°	°	°	°	°	°	°	°	°	°	°	°	°	°			
Keswick	54 33	3 9	240	36·36	40·04	39·90	44·38	52·25	56·63	59·48	59·68	53·45	47·77	41·23	36·20	47·28	58·60	23·48	4$\frac{2}{3}$	6, 12, 1, 6	Dove.
Whitehaven	54 33	3 33	. .	38·47	39·53	41·15	46·22	53·72	58·45	60·60	59·87	55·79	49·86	43·65	41·70	49·09	59·64	22·13	12	Daily extr.	Dove.
Carlisle	54 54	2 58	. .	36·19	38·59	40·49	44·82	51·16	55·69	58·48	58·01	53·81	48·09	41·33	36·97	46·97	57·39	22·29	24	8, 1, 9	Dove.
Durham	54 47	1 33	. .	33·2	40 5	40·6	43·6	55·5	55·2	58·3	54·	53·2	47·6	40·9	40·1	46·9	55·08	25·1	1	Daily extr.	Rep. of Reg.-Gen.
SCOTLAND.																					
Applegarth-manse	55 13	3 12	180	36·75	37·3	41·05	46·1	52·	56·2	57·5	57·1	54·25	47·45	42·5	39·6	47·32	56·9	20·75	9	Daily extr.	Phil. Mag.
Leadhills	55 25	3 48	1280	32·	34·8	37·5	42·95	49·65	55·05	57·2	54·95	50·45	44·05	37·5	33·3	44·12	55·73	25·20	10	6, 1 red.	Dove.
Makerstoun	55 36	2 31	213	32·3	38·6	41·3	44·6	51·6	56·8	55·85	57·55	54·3	44·25	38·05	44·8	46·67	56·73	25·25	1$\frac{1}{2}$	Daily extr.	Dove.
Glasgow	55 51	4 14	. .	38·23	39·48	. .	45·96	54·96	59·33	61·25	59·78	. .	49·97	42·38	41·33	49·27	60·12	23·02	9	10, red.	
Carbeth	56 0	4 22	480	35·74	38·02	40·22	42·19	50·05	56·39	60·53	59·02	54·50	46·58	42·37	36·18	46·82	58·65	24·79	4	10, A.M. red.	Dove.
Colinton	55 55	3 16	364	36·78	38·23	40·31	45·35	52·12	57·29	59·17	58·22	52·98	48·75	40·13	39·87	47·83	58·23	22·39	5	8, 8	Dove.
Edinburgh	55 58	3 11	220	37·38	38·22	40·53	44·18	50·34	56·03	58·69	56·79	53·44	48·79	41·43	39·75	47·13	57·17	21·31	17	Daily extr.	Dove.
Hawk's Hill	55 58	3 10	. .	36·5	38·75	42·8	48·2	52·03	57·88	61·48	61·03	55·18	48·88	40·10	38·08	48·41	60·13	24·98	3	. .	Dove.
Leith	55 59	3 10	. .	41·09	40·62	40·87	46·38	50·01	56·09	60·36	58·37	56·31	49·23	41·19	39·78	48.36	58·27	19·74	2	Hourly	Edin. Trans. 1826.
Bonally	56 0	3 10	1100	34·68	35·92	36·70	40·75	47·48	53·50	55·96	54·48	49·86	45·62	38·23	37·38	44·21	54·65	21·28	5	8, 8	Dove.
Dunfermline	56 5	3 26	. .	35·71	37·89	39·	41·85	48·23	53·75	56·85	54·97	50·96	46·41	40·66	36·41	45·22	55·19	21·14	20	9 red.	Dove.
St. Andrew's	56 21	2 48	70	37·25	40·	42·17	46·03	51·58	57·19	60·35	59·30	55·69	49·56	43·17	40·41	48·56	58·95	23·10	8	10, 10	Dove.
Kinfauns Castle	56 23	3 19	140	35·99	38·17	40·70	44·85	50·3	55·81	58·45	57·39	53·43	47·13	41·79	38·66	46·89	57·22	22·46	22	Daily extr.	Dove.
Aberdeen	57 9	2 5	50	37·82	39·03	42·80	47·57	54·29	58·49	60·47	59·64	56·72	49·97	43·18	40·18	49·18	59·33	22·65	8	8	Dove.
Clunie-manse	57 12	2 35	. .	36·46	38·29	41·20	45·65	51·91	57·07	59·59	57·63	53·21	47·67	40·72	38·15	47·30	58·10	23·13	16	10, 10	Dove.
Alford	57 13	2 45	420	33·30	35·46	37·86	42·56	50·15	55·45	57·46	56·54	51·57	44·11	38·55	37·94	45·08	56·46	24·16	10	9$\frac{1}{2}$, 8$\frac{1}{2}$	Dove.
Elgin	57 38	3 16	. .	37·56	39·67	40·53	43·54	51·82	59·53	61·23	60·45	53·35	46·98	40·44	38·11	47·77	60·40	23·67	3	9 red.	Dove.
Wick	58 29	3 5	. .	38·57	37·93	41·94	44·04	49·30	53·11	56·47	56·42	54·42	48·32	42·84	39·96	46·94	55·33	18·54	2	Red.	Dove.
Stromness (Orkney)	58 57	3 18	. .	38·05	38·91	40·78	42·29	48·33	53·03	55·37	54·86	52·36	48·61	42·44	41·08	46·34	54·42	17·32	12	10, 10	Dove.
Sandwick-manse (Ork.)	59 05	3 17	. .	39·57	38·42	40·7	43·77	48·37	52·79	54·61	55·41	52·24	46·93	43·24	40·92	46·41	54·27	15·84	7	. .	Phil. Mag.
Unst (Shetland)	60 45	1 41	. .	40·3	38·75	40·4	42·6	46·2	50·8	52·75	54·5	50·7	43·35	39·	37·	44·70	52·68	17·50	1	7$\frac{1}{2}$, 8$\frac{1}{2}$	Edin. Phil. Jour.
Thornshaven (Faro Is.)	62 6	6 46	. .	37·56	36·9	37·52	41·81	45·37	53·44	55·87	54·55	51·50	45·95	41·69	42·63	45·40	54·62	18·97	. .	. .	Dove.
IRELAND.																					
Dublin	53 21	6 11	. .	39·96	41·33	43·64	47·17	52·01	57·18	60·53	60·22	55·75	49·55	42·61	42·81	49·09	59·31	20·57	10	Daily extr.	Trans. of Irish Acy.
Cork	52 0	9 0	. .	43·91	44·47	48·02	53·9	60·3	65·13	65·47	64 87	61·3	53·33	47·93	44·36	54·41	65·15	21·56	10	. .	
Edgeworthstown	53 40	7 36	. .	39·	38·	42·	50·	50·	60·	58·	61·	50·	46·	39·	38·	48·	59·66	. .	1	. .	Trans. of Irish Acy.
Belfast	54 35	5 55	. .	39·02	40·02	43·1	44·4	54·6	59·05	60·7	59·85	54·16	49·51	42·72	41·82	49·	59·83	. .	. .	Red.	
Antrim	55 0	6 30	. .	32·	38·75	41·25	49·75	49·25	53·75	60·75	60·	54·25	51·50	43·75	39·50	47·87	58·16	28·75	. .	. .	Trans. of Irish Acy.

7. By consulting the table it will appear that the mean annual temperature of the south-western coast of England at the level of the sea is about 52°, and under nearly similar circumstances at the Orkney Islands, from carefully recorded observations, it is found to be 46°·3; thus there is a decrease of annual temperature amounting to 5°·7 from the southern to the northern extremity of Great Britain, extending through 9° of latitude, or 635 English miles, *which gives a decrease of one degree for every* 111 *miles.* An intermediate point on the sea-coast will serve to test this rate of diminution. At Whitehaven, for instance, which is 300 miles from the south coast, the ratio of decrease stated amounts to 2°·8, which deducted from the temperature of the south coast 52°, gives 49°·2 for Whitehaven, a very near approximation to the observed mean temperature 49°·09.

8. The mean temperature increases from the eastern to the western coasts: at Greenwich it is 49°, at Penzance 51°·8, at Cork 54°·4, being *at the rate of one degree increase for every* 66 *miles.* Thus the mean temperature of the British Islands increases from east to west, twice as much in the same distance as it does from north to south, other things being equal.

9. The annual amount of heat, indeed, on the *coast* line of Great Britain, is remarkably equal: at Penzance the mean temperature is 51°·8; Gosport, 51°·8; Boston, 49°·6; Leith, 48°·3; Aberdeen, 49°·1; Glasgow, 49°·2; Whitehaven, 49°·1; Isle of Man, 49°·8; Dublin, 49°·1; and at Swansea 51°. Thus on a coast line of about 2000 miles, the variation is only 4°.

10. In passing from the coast inland, a considerable diminution of temperature often takes place. Leaving Aberdeen at 49°·1, 47°·3 is found at Clunie Manse, and 45° at Alford, and that within a distance of 25 miles. In the middle of England the mean of the year is also from 2° to 4° colder than places situated on the coast: this arises partly from the effect of elevation, and from the modifying influences of sea-breezes which the coast lands enjoy.

11. The annual mean temperature of a country is, however, but a slender criterion from which to form an estimate of its climate, and is especially defective when the influence of climate on vegetation is considered. Penzance and Vienna have the same mean temperature; but the country around Vienna—the upper Hungarian plain—has a summer temperature 10° above Penzance. In the excessively cold winter of 1796, when the Thames was frozen, the temperature of the year in this country fell short of the *average* by only 1°. M. Arago states that, in the two years 1815 and 1816, the latter of which was destructive to the crops in a great part of France, the annual temperature varied only 2° from the standard. It is more a change in the distribution of

heat through the different months, than a change in the mean temperature, that disappoints the expectation of the husbandman and causes a scanty crop.

12. In endeavouring to trace the increase of winter cold from south to north, an extraordinary fact springs up on the very threshold of the inquiry, viz., that the month of January *is warmer at the north of Scotland than in the country round London.* At Greenwich and Chiswick the mean of the month is 36° and 37°, whilst at Wick it is 38°·5; at the Orkney Isles, 39°·5; and at Shetland 40°. The intermediate points on the coast line also confirm this remarkable distribution of heat; the January temperature of Glasgow on the west, and of Aberdeen on the east coast, being 38°. The cold winters of some of the northern and midland districts result rather from their position and elevation than from any difference in latitude. The country extending from London through the middle of England to York, including the parallel eastern coast, has the lowest winter temperature of the kingdom in proportion to its altitude. Passing from this district to the western coast, a considerable increase of the January temperature takes place: at Liverpool it is 4° higher than at Boston, on the opposite side of England. Further south this progression may be more definitely traced; thus the mean of January at Greenwich is 35°·5; Chiswick, 37°; Isle of Wight, 38°; Truro, Helston, and Penzance 42°·6; northward at Swansea it is 42°; and from thence to Cork it rises to 44°. The warmest winter temperature is therefore found on the south-west coast of England, and in South Wales; but it is more particularly evident on the low lands of the south coast of Ireland.

13. The increase of winter cold in various parts of these islands (and which is often so severe as to convert a productive soil in one position into a state of comparative barrenness in another) cannot mainly be attributed to a difference of latitude, for, as has been shown, where all things are equal, as on the sea coast, a great equality of temperature prevails. It is now satisfactorily ascertained that the temperature of different places in this kingdom is affected less by latitude than any other part of the world within the same isothermal zone. The lines of mean temperature of 41° and 50°, laid down by Humboldt, fully demonstrate this. But when the true position of these lines is more accurately determined by the valuable tables of Professor Dove,* their want of parallelism becomes much more apparent—this zone of temperature on the American coast being only about 300 miles wide; but at the British Isles it is extended to a width of 1100 miles, a striking proof of the equable nature of our

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* See the chart which accompanies this Essay.

climate; it therefore becomes obvious that the severe winter temperature of various districts arises from other causes, amongst which the most prominent is the effect of elevation.

14. Whilst it is really difficult to show that latitudinal distance has any marked effect in Great Britain on winter temperature, a few hundred yards of change of altitude produces an increase of cold—at first detrimental, and then destructive of remunerative agriculture. The trap-rocks of Scotland, so fertile in low situations, present a scene of desolation on the hills. The grauwacke of Wales, yielding fair crops on the coast, becomes barren on the mountains. And the rich granite soil on the west of Penzance has all its productive powers nullified on the high lands of Bodmin-moor and Dartmoor. The effect of altitude on climate is thus a practical as well as an interesting question.

15. A detailed inquiry in the "Encyclopædia Britannica," under the article Climate, gives the following results for the ascents due to the decrement of one degree Fahrenheit at the surface, and at the heights of 1, 2, 3, 4, and 5 miles; viz. 300 feet, 295, 277, 252, 223, and 192. This in practice amounts to 1° for every 100 yards of altitude.

The comparative observations made at Geneva and St. Bernard give 352 feet for 1°;* very nearly agreeing with Humboldt's equatorial observations. But the rate of progression increases in colder climates, and continental observations will not apply to the insular position of these islands. It is therefore desirable that observations made on British hills should form the basis of our inquiry. I have extracted accordingly from the 'Transactions of the Royal Irish Academy' the following observations made by General Roy, and have deduced the result:—

TABLE II.—Showing the effect of Elevation on the Temperature of the Air.

Place.	Lat.	Heights in Feet.	Temperature by Observation.† Below.	Above.	Difference.	Decrease of Temperature for 100 Feet of Elevation.
			°	°	°	°
Arthur's Seat, Edinburgh	56	803	54	50·5	3·5	0·43
Glenmore	56½	1279	55	51·5	3·5	·26
Bolfrack	56½	1076	60	56·75	3·25	·31
Knockfarle	56½	1364	54	48·5	5·5	·40
Kirk Yetton	56½	1544	54·5	47·25	7·25	·46
Snowdon	53	3555	60	47·75	12·25	·37
						6)223
					Mean	·37

* First Report of British Association, p. 219.

† The scale of temperature used throughout this Essay is that of Fahrenheit.

16. The mean of the whole corresponds with the decrement of Snowdon, viz. 37-100ths of a degree for every 100 feet, *or* 1° *decrease for every* 270 *feet of altitude.*

If the mean annual temperature of Leith is compared with that of Bonally, in the same latitude, at an increased elevation of 1100 feet, there is a difference in the year of 4° 15′; which gives for a decrease of 1° of temperature, an ascent of 264 feet, nearly agreeing with the previous result.

It is also satisfactory to find that the decrease of temperature observed by Lagrange for *small heights*, is stated to be 1° for 270 feet of altitude.* This result may, therefore, be taken as an approximation near enough for all practical purposes.†

17. These observations tend to fix the height of the snow-line on the south of England at 5400 feet, and on the north of Scotland at about 4000 feet. In the month of January the snow-line descends in South Wales, Devon, and Cornwall to 2700 feet above the sea; in Scotland to 1620 feet; and on the eastern coast of England to 1080 feet. It is obvious, therefore, that the high lands of Wales, the north of England, and Scotland, must be exposed to a severe and rigorous winter—the fluctuating character of which renders it still more detrimental to vegetable and animal existence.

18. The effect of elevation on the climate of these islands is, however, not so injurious to agriculture by increasing the winter's cold, as it is by diminishing the summer's heat. Our grain-producing plants are natives of a warmer climate; wheat, in particular, not only bears, but comes most profitably to perfection where in England the highest summer temperature exists; whatever tends to diminish that temperature has a corresponding injurious effect on the products of the harvest.

19. One of the most important agricultural elements of climate is the amount of summer's heat. A certain quantity of heat distributed through the summer months is requisite for the perfect maturity of the white crops; where the temperature barely reaches the standard, there will often be a deficiency in the amount of produce, and more often a defect in the quality of the grain. And where the summer temperature falls below the standard, it is in vain for the husbandman to struggle against a destiny he cannot withstand—inferior grain crops, roots and pasture, are then his best reliance. The summer temperature of the cultivated lands of Great Britain varies from 64 to 54 degrees; and on mountainous districts it is still lower. These limits include a climate well adapted to bring the wheat-crop

* First Report of British Association, p. 220.

† The decrease of temperature on the Pentland Hills, as observed by Professor Forbes, is 1° for every 230 feet of altitude.—'Transactions of Edinburgh Royal Society, 1840.'

to full perfection, and also a condition of heat insufficient to ripen this grain, where only oats and inferior kinds of barley can be judiciously raised. Much of our land, particularly in Scotland, is thus on the very verge of the profitable cultivation of wheat. The amount of summer heat, therefore, becomes a question of paramount importance in respect of the husbandry of these lands.

20. The mean summer temperature of the south coast of Cornwall is from 60° to 61°; thence to the Isle of Wight it increases to 62° and 63°; along the coast line to Boston it falls to 62°; northward to Leith it decreases to 58°; which temperature is more than maintained northward and westward to the Murray Frith; at Wick it falls to 55°; and at the Orkneys to 54°. Thus from the south of England to the Murray Frith, the summer temperature decreases on the coast line at the level of the sea about 5°, *being a decrease of* 1° *for every* 100 *miles.* Judging from Glasgow, the same, or a somewhat increased amount of summer temperature is maintained on the western as on the eastern coast of Scotland, although it has the reputation of being much milder; the Isle of Bute being "the Madeira of Scotland." But this mildness applies to the winter, rather than the summer months. Continuing the coast-line of summer temperature, at Whitehaven it amounts to 59½°; at the Isle of Man, 59°; at Dublin, 59¼°; and on the low coast lands of South Wales, 62½°.

Extending our survey inland, it appears that the eastern counties, and the midland counties around Bedfordshire, have, as a whole, the highest summer temperature in England.

21. But it is in the English vales where the most genial summer heat abounds. These, from their low, sheltered position, and from the geological structure of the soil, are the most highly favoured parts of Britain's favoured isle. The fruitful lands of the Vale of York, extending from the Humber along the Ouse and the Swale, and including a surface of nearly 1000 square miles, have a summer temperature of 62½°. The rich Vale of the Severn is situated further south, longitudinally exposed to the full effect of the midday sun, and sheltered by surrounding hills from the west and east winds, has a summer temperature of 64°. Including the Vale of Gloucester and the Vale of Berkeley, this district has a climate which more nearly approximates to that required for the culture of the vine than is found in any other part of England. It is not, therefore, surprising that in such a favoured spot—"Nature's noble garden"—vineyards were in past days abundant, and that here they struggled to maintain an existence through many a lingering year. It has been inferred from this fact that there has been a decrease in the summer temperature of England; but it is more probable that, as the cultivation of the sugar-cane deserted in

succession the south of Spain, the north of Africa, and the Canary Islands, for a climate more adapted to its perfect development in the West Indies; so the vine, introduced into England and carefully nourished as a valuable exotic, has ultimately deserted a clime unsuited to the perfection of its rich luscious juice, or only lingers as a good illustration of the value of meteorological science in determining the course which the husbandman should most successfully pursue.

22. A geological map shows at a glance that the soil of many of the vale-lands of England is composed of the new red-sandstone formation; and even their general extent may often be traced on the map by the limit of the characteristic colour. This is the case with regard to the vales of York, Stockton, Trent, and of the Severn. Smaller vales, like fertile gardens surrounded by elevated lands, display the same peculiarity, and afford good illustrations of this fact. It may be seen in the vale of Carlisle in the north of England, of Clwyd in North Wales, and of Taunton Dean in Devon.

The fragmentary and siliceous nature of the soil on the new red-sandstone renders it very susceptible of the influence of solar heat, and when exposed to the sun's rays, its temperature is rapidly raised, and the radiation of heat which follows tends considerably to increase the temperature of the superincumbent air.

23. The observations necessary for forming a correct knowledge of the temperature of Ireland are very scarce, particularly in respect to its western coast. From the very accurately recorded observations I have obtained from Cork, it appears that the low lands on the south coast enjoy the high mean temperature of 54°. At Dublin the mean temperature is 49°, corresponding with the eastern coast of England in the same latitude; and the north of Ireland has a mean temperature of 48°.

The summer heat around Cork is greater than in any other part of the British Islands, being 65°: at Dublin it amounts to 59°, and in the northern counties to 58°. The general elevated character of the lands in the interior, with the large amount of evaporating surface presented by the bogs, tend to decrease the summer temperature of the inland districts. A compensating effect is in some measure produced from the thin, friable, and easily heated soil of the limestone formations, which extend over three-fourths of the island. But the climate of Ireland at all seasons is more tempered and modified by the influence of the Atlantic Ocean than any other portion of the British Isles. The prevailing warm westerly winds,* loaded with moisture, sweep over the land, producing cool damp summers, and mild wet win-

* At Cork the wind blows between the south and the north-west three-fourths of the year.

ters, and equalizing the temperature of the different seasons to a remarkable degree.

24. The difference between the mean temperature of day and night, is given in the following table for the places mentioned. It shows that on the sea coast the change is comparatively little in winter, and that it is greatest in the inland districts in April and May. Store or young cattle kept in warm houses through the winter, are in danger of suffering from this fluctuation of the temperature when "turned out" early in the spring.

Table III.—Showing the Mean Difference between Night and Day for each Month in the Year.

Place.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Truro . . .	6°·8	6°·7	8°·8	12°·3	13°·4	13°·6	11°·4	11°·8	11°·3	10°·1	7°·9	6°·9
Exeter . .	8·6	9·6	12·3	13·5	15·5	15·6	15·1	14·6	13·4	11·4	9·4	7·1
Chiswick . .	11·8	12·9	17·0	22·8	23·6	22·8	21·2	21·1	19·4	17·8	14·2	12·7
Norwich . .	6·5	5·4	12·2	16·0	27·8	18·5	17·3	16·8	14·9	10·1	8·4	7·9
Dumfriesshire	9·1	9·0	11·9	15·6	16·8	15·2	12·5	13·8	14·1	11·5	9·6	8·2
Whitehaven .	8·8	7·6	10·1	12·5	15·4	12·9	11·0	11·0	9·6	7·0	7·5	6·4

25. The general slope of various districts in the United Kingdom tends perceptibly to augment their temperature. The lands around Cork, the coast of South Wales, the Isle of Wight and contiguous lands, the South Hams of Devon, and the far-famed neighbourhood of Penzance, are districts more or less sheltered from the chilly influence of northerly winds, and open to the full effect of the sun's rays, and to the warmth communicated by the higher temperature of the waters of the adjoining sea.

26. The low country at the foot of the Highlands, extending along the coast from Dundee to Aberdeen, and even as far as Elgin, has a very high summer temperature in respect to latitude, and to other parts of Scotland, being from 58° to 60°. This accounts for the perfection with which wheat is raised in the lowlands of this district, and for the fine samples now grown so far north as the Murray Frith.

27. The geological structure of the soil influences in a perceptible manner the temperature of the air. I have often found an oppressive heat on a summer's evening at nine o'clock, when walking over bare sands after a hot day; and in proportion as soils are siliceous and gritty, they receive and radiate heat. The fragmentary nature of the crag of Norfolk and Suffolk, and the sands of the tertiary strata, render the soil very susceptible of the influence of solar heat, and therefore well adapted to bring the barley crop to its highest perfection. A belt of warm siliceous soil runs from Cambridge in a south-west direction through the counties of Bedford, Buckingham, Oxford, and Berks. It lies on portions of the green-sand formation, and is

adapted, by its temperature, and the ease with which it is worked, to gardening operations. There are extensive market-gardens in the parishes of Sandy and Gritford (names evidently derived from the nature of the soil), in Bedfordshire, where large quantities of vegetables are raised for London, Cambridge, &c.

The new red-sandstone has a soil readily receiving and communicating heat; it is spread over the vales and low lands of England, and wherever it appears there is fertility and beauty of scenery. The temperature of Cheshire is not so high as might be expected from its shelter, situation, and red-sandstone soil. This arises from the extensive pastures, and from the wood so thickly scattered over its surface. If the soil of Cheshire was used as arable land, and less timber grown in the hedgerows, the summer temperature of the county would be raised equal to that of other arable districts. The gravel and conglomerates of the old red-sandstone constitute a warm soil, and even its clays, when well drained, readily receive the solar heat, and will therefore pay for this kind of improvement better than any other soil.

The soil on all the Plutonic rocks (with the exception of Serpentine) is of a friable, warm nature; this is particularly the case where hornblende prevails in the trap rocks. The early potatoes grown near Penzance, and which go into the London markets in May, are raised from this soil.

Where granite is found, at 100 or 200 feet above the sea, the soil is remarkably early and prolific. Near the Land's-end and the Logan rock such a soil produces from 40 to 50 bushels of wheat, and 60 bushels of barley an acre; but at an elevation of 800 feet and upwards, granite becomes a very unproductive soil. The increased quantity of rain which falls at that height does not readily find its way through the close texture and fissures of this rock, so that swamps are formed in the flat lands and valleys, and even the hill sides are generally covered with peat: this soil, so warm on low situations, becomes wet and cold on the hills. There is no land whose powers are so rapidly impaired by elevation, or which produces such contrary effects on the temperature of the air, as that which lies on the granite.

But a large portion of the soil of these islands, particularly in England, is of a heavy, cold nature, and not well adapted to the reception and communication of heat: this is the character of the stiff yellow clay of the coal-measures, of the soil of the Weald of Kent, and of the lias and other clays.

28. The rocks and soils of which the elevated districts are composed are, from their structure, unfortunately favourable to the production of peat. The close structure of the granite, and its defective drainage in wet situations, have already been noticed. The slate districts of the south of Scotland, Cumberland, Wales, and Cornwall have a better under-drainage, but the soil is much

heavier, and a stratum of clay generally forms the subsoil. At a moderate altitude, and especially where trap rocks have been intruded, this soil will bear as much as 40 inches of rain annually without injury to the crops; but on high lands, where a much larger quantity of rain falls, it cannot percolate through the clayey subsoil, and either runs in torrents off the mountain-side, or gathers into pools and lakes on the flat and basin-shaped lands. It is to the heavy rains on elevated lands and the inability of the rock to absorb this excess of moisture, that the extensive peat-mosses of Scotland and England, and the bogs of Ireland, owe their origin. This wet state of the soil tends to lower the summer temperature of such lands below what might be expected from their situation; the rays of heat do not effectually penetrate the soil, and the constant evaporation tends to chill both the soil and the air.

The valuable observations of Mr. Parkes show, that in the month of June the temperature of a bog at 7 inches below the surface was 47°, whilst that of worked soil at the same depth varied from 49° to 66°.* On the 16th of September, the air in the shade being 65°, I ascertained that the temperature of the upper two inches of garden-mould exposed to the sun's rays was 84°. At 4 inches deep the thermometer stood at 69°. There is, therefore, a great difference between the reception and consequent radiation of heat by the surface of a bog and by worked soil.

29. The low summer temperature of the great central plain of Ireland arises chiefly from this cause. Its undulating surface is only from 100 to 200 feet above the level of the sea, but the compact structure of the mountain limestone retains the rain-water on its surface; hence the extensive bogs and low summer temperature of this region. Partial and detached efforts to drain and cultivate this land will be attended by many disadvantages, but a general and effective system of drainage would not only reclaim the soil, but materially improve the climate.

30. *Rain.*—The evaporation constantly arising from the surface of the earth and the sea, on meeting with a colder stratum of air, becomes visible in the form of clouds, which on a further decrease of temperature form small globules of water, and ultimately falls in rain. The general amount of rain is therefore in proportion to the quantity of vapour raised into the air, the direction in which the clouds are carried by the prevailing winds, and the change of temperature necessary for condensation. Equatorial regions have, therefore, a much larger quantity of rain than falls in temperate climates; and according to the scale laid down by Humboldt, and which decreases from the equator northward, the amount which falls in this country should be about 22 inches annually.

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* Journal of Royal Agricultural Society of England, vol. v. p. 142.

But the soil of these islands receives a much greater amount, Dalton's estimate of the average annual quantity for England being 31·3 inches. More recent observations on elevated land have shown that the western mountainous districts are drenched with enormous quantities of rain, equal to some of the wet regions within the tropics.* This appears to arise from the following combination of causes:—

31. The waters of the Gulf of Mexico, augmented by the equatorial current, confined for a season as in a caldron, are heated under a tropical sun to a temperature of 86°. The Gulf-stream carries this warm water northward and eastward into the middle of the Atlantic, where it is spread over an area at least equal to four times the extent of France. A more than ordinary evaporation arises from this part of the ocean; the prevailing south-west wind, after sweeping this part of the Atlantic, arrives at our western shores laden with moisture; the colder air of the mountain districts condenses the vapour, and the result is—an abundance of rain.

32. The following table has been collected from the authorities therein mentioned, and is so arranged with regard to the latitude of the places named, that the eye can trace in order the annual amount of rain which falls on the western and eastern sides of Great Britain.

Table IV.—Showing the Annual Fall of Rain at the places mentioned.

Places.	Mean of Years.	Height in Feet.	Rain in Inches.	Authorities.
The Western Coast, and elevated Lands:—				
Sandwick, Orkney	7 (1812 to 1848)	..	36·8	Phil. Mag.
Dunoon	..	..	56·	Milner.
Greenock	..	..	40·	Ditto.
Glasgow	30	..	30·	M'Culloch.
Carbeth, Stirling	8	..	42·5	Ditto.
Mount Stewart, Bute	7	..	46·6	Ditto.
Applegarth Manse	10 (1839 to 1848)	..	33·6	Phil. Mag.
Cockermouth	4	..	48·5	Trans. of Royal Soc.
Whitehaven	4	..	47·1	Ditto.
Keswick	4	258	63·6	Ditto.
Gatesgarth	4	326	121·4	Ditto.
Seathwaite	4	..	146·4	Ditto.
Kendal	4	..	58·	Journal of Science.
Isle of Man	5	..	36·2	Ditto.
Liverpool	..	..	34·1	Prout, Bridgewater Treatise.
Bolton	4	320	44·	Report on Supply of Water to Manchester.
Rochdale	4	500	47·5	
Manchester	..	..	36·1	Prout, Bridgewater Treatise.

* Seathwaite, Westmoreland—av. 4 yrs.—146 inches; St. Domingo, 120 inches; Grenada, 112 inches.

TABLE IV.—*continued.*

Places.	Mean of Years.	Height in Feet.	Rain in Inches.	Authorities.
Swansea	5	. .	36·6	Jenkins.
Monmouth	. .	. .	30·	Milner.
Cheltenham	7	. .	31·8	Agricultural Gazette.
Bath	. .	. .	30·	Milner.
Bristol	. .	. .	29·2	Prout.
Exeter	10	. .	32·6	Extracted and deduced from the Reports of the Royal Institution of Cornwall.
Tavistock.	5	. .	53·6	
Good-a-moor (under Dartmoor)	4	. .	57·5	
Truro	10	55	44·	
Falmouth	5	. .	43·7	
Penzance	7	. .	44·7	Phil. Mag., vol. iii. 182.
THE EASTERN COAST :—				
Inverness	. .	. .	26·	Milner.
Alford	6	. .	37·9	Edin. Phil. Jour., 1841.
Clunie	. .	. .	25·	Milner.
Dundee	9	. .	22·	M'Culloch.
Lanfargan-on-Tay . .	12	. .	24·5	Ditto.
Annat Cottage, Perthshire	"Cycle of years."	. .	27·	
Edinburgh	. .	. .	25·	Milner.
Dalkeith	. .	. .	22·	M'Culloch.
Peebles	14	. .	28·7	Ditto.
Kinfauns Castle . . .	. .	140	25·6	
Hill near ditto . . .	. .	600	41·5	
Norwich	. .	. .	25·5	
York	. .	. .	23·	Milner.
Ackworth	. .	. .	26·	Phil. Mag., vol. xvi. 60.
Derby	. .	. .	27·	Milner.
Boston	10	. .	24·9	Phil. Mag.
Shields	. .	. .	25·	Milner.
Thetford	. .	. .	19·	Ditto.
Cambridge	. .	. .	20·	Ditto.
Bedford	. .	. .	27·	Ditto.
Oxford	. .	. .	22·	Ditto.
Aylesbury	. .	. .	21·	Ditto.
Abbot's Hill, Herts . .	8	. .	26·6	Dickinson.
Greenwich, Royal Observatory	7	159	24·3	Rep. of Reg. Gen., 1837.
Chiswick	10	. .	24·4	Phil. Mag.
Cobham, Surrey . . .	4	. .	25·2	Rep. Cornwall Inst.
London	. .	. .	22·2	Daniell.
Hastings	. .	. .	28·	Milner.
Gosport	3	. .	29·5	Dr. Burney.
IRELAND :—				
Londonderry	1	. .	29·	Trans. of Irish Academy.
Ditto	. .	. .	35·	Petermann.
Armagh	. .	. .	21·7	
Dublin	10	. .	24·6	Trans. of Irish Academy.
Edgeworthstown, Longford	1	. .	35·5	Ditto.
Colooney, Sligo . . .	. .	. .	42·	
Toomevara, Tipperary .	. .	. .	40·5	
Cork	10	. .	40·2	Cork Institution.
Limerick	. .	. .	35·	Petermann.
(67 Stations.)				

33. This table shows, that on the cultivated soil of the south-west of England about 44 inches of rain fall annually. On the great eastern plain of England—having Greenwich and Chiswick on the south, and Boston on the north, at which places careful observations have been made—24 inches are the yearly quantity. Along the fertile lowlands of the eastern coast of England and Scotland, as far as Inverness, with some minor variations, the same amount is received by the soil. On the western coast, the grauwacke hills of the south of Scotland, Cumberland, Wales, and Cornwall, attract and condense the clouds passing from the Atlantic, and so receive the largest quantity. Much soil on this formation is of a friable nature, and readily allows the water to percolate through it; and if the beds of slate lie on their edge, the water rapidly passes into the fissures of the rock. But where the stratification is horizontal, the thin soil becomes water-sodden and weak.

Generally the western hills and the adjoining lowlands have more open soils than the midland districts, and require more moisture. There is an old adage that "Cornwall will take a shower every day of the week, and two on the Sunday." These hills also form a sort of natural drainage, drawing off from the clouds that excess of water which would be injurious to the stiff wheat soils of the midland counties.

The general elevation of the rain-clouds appears to be from 500 to 2000 feet. The detached mountain bosses of Ireland and the lowlands near are the wettest parts of the country. The central plain not rising higher than 200 feet, permits these clouds to pass onward with a casual, yet frequent tribute, and it is not till they are intercepted by the Cumberland mountains that the abundance of their contents is discharged in torrents of rain. The hills of the Pennine chain shelter and protect the vale of York from these libations of nature.

34. The distribution of the annual quantity of rain through the different months has an important influence on seed-time, the ripening and harvesting of corn, &c. It is given in Table V.

35. An examination of this table shows that the months of spring form the dryest season of the year. In the midland and eastern districts March is a dry month; in the south-west counties April has the least amount of rain; and in the lake district of Cumberland May and February are the dryest months. Here is a general adaptation of nature to the requirements of seed-time, and the observing husbandman, who works his land at a proper season, will rarely fail of getting it into a good state of tilth for his spring crops. The month of July has nearly its full share —a twelfth part of the whole; and August is still wetter; so that during the ripening of corn, and at harvest, a larger quan-

TABLE V.—Showing the Average Quantity of Rain

Names of Places.	Mean.	Lat. N.	Lon. W.	Elevation.	Jan.	Feb.	Mar.	April.
	Years (inclusive).	° ′	° ′	Feet.				
Penzance	7, 1821 to 1827	50 7	5 33	..	3·83	3·26	3·88	1·82
Truro	10, 1839 to 1848	50 18	5 4	..	4·66	3·79	3·44	2·54
Tavistock	5, 1838 to 1842	50 34	4 6	..	3·7	4·5	3·5	1·9
Good-a-Moor (under Dartmoor)	4, 1840 to 1843	..	..	..	6·05	4·14	3·82	2·2
Exeter	10, 1839 to 1848	50 43	3 30	..	3·32	2·35	2·34	1·9
Gosport	3, 1825 to 1827	50 46	1 3	..	1·123	1·963	2·753	1·6
Cobham	4, 1840 to 1843	..	..	..	2·24	2·38	1·72	1·2
Chiswick	10, 1839 to 1848	..	..	..	1·95	1·66	1·43	1·4
London	40, ...	51 30	0 4	..	1·464	1·250	1·172	1·2
Swansea	5, ...	51 38	3 56	..	3·66	2·56	2·66	2·2
Boston	10, 1839 to 1848	53 0	..	..	1·59	1·45	1·52	1·5
Manchester	33, ...	53 30	2 11	..	2·310	2·568	2·098	2·0
Lancaster	20, ...	54 1	2 45	..	3·461	2·995	1·753	2·1
Kendal	25, ...	54 21	2 45	..	5·299	5·126	3·151	2·9
Abbot's Hill (Herts)	8, ...	..	..	..	1·85	1·97	1·62	1·4
Isle of Man	5, 1826 to 1830	54 15	4 25	..	2·08	2·68	2·44	3·2
Keswick	3, 1845 to 1847	..	..	258	4·87	2·63	4·60	4·2
Whitehaven	3, 1845 to 1847	54 32	3 30	..	3·67	2·22	3·18	2·6
Seathwaite	3, 1845 to 1847	..	..	240	13·39	7·75	11·20	8·3
Applegarth Manse, Dumfriess.	10, ...	55 13	3 12	180	2·63	2·30	2·37	1·6
Sandwick (Orkney)	7, 1842 to 1848	59 05	3 17	..	3·65	3·09	3·01	1·9
Dublin	10, ...	53 21	6 16	..	2·15	1·86	1·57	2·2
Londonderry	1, ...	54 59	7 20	..	3·81	0·63	0·63	4·0
Edgeworthstown	1, ...	53 42	7 34	..	5·80	1·91	1·27	2·8
Cork	10, ...	52 0	9 0	..	4 47	3·33	3·23	2·4

Inches, for each Month, at the places mentioned.

May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Authorities.
3·06	2·14	2·96	3·50	3·44	5·61	5·19	6·01	44·70	Mr. Giddy, Phil. Mag., Mar. 1828.
2·41	2·79	2·64	3·04	3·68	4·08	6·11	4·90	44·08	Extracted from the Report of the Royal Inst of Cornwall.
3·4	3·5	4·6	4·2	5·3	5·	8·9	5·1	53·6	
4·66	3·28	3·25	5·42	5·06	5·32	9·96	4·27	57·50	
2·14	2·26	1·91	2·59	2·60	3·69	4·67	2·74	32·58	
2·464	1·376	0·966	2·232	3·606	3·362	3·400	4·628	29·473	Dr. Burney, LL.D., Phil. Mag.
3·19	1·44	2·27	2·93	3·57	2·88	4·41	1·96	25·25	Report of Royal Inst. of Cornwall.
1·85	1·79	2·05	2·75	2 37	2·92	2·70	1·53	24·40	Phil. Mag.
1·636	1·738	2·448	1·807	1·842	1·092	2·222	1·736	20·686	Farmers' Ency.
2·01	2·33	2·78	4·28	2·16	4·93	4·	3·04	36·68	Jenkins, Rep. of Brit. Assoc. 1848.
2·17	2·41	2·77	2·83	2·24	2·72	2·26	1·44	24·90	Phil. Mag.
2·895	2·502	3·697	3·665	3·281	3·922	3·360	3·832	36·140	Farmers' Ency.
2·460	2·512	4·140	4·581	3·751	4·151	3·755	3·955	39·714	Ditto.
3·480	2·722	4·959	5·089	4·874	5·439	4·785	6·084	53·944	Ditto.
1·85	2·21	2·29	2·42	2·64	2·82	3·84	1·64	26·61	Dickinson.
1·96	1·96	2·75	3·49	3·43	3·77	4·02	4·59	36·25	Journal of Science.
3·02	4·12	4·94	5·85	4·41	9·0	8·35	6·66	62·72	Trans. of Roy. Soc.
2·40	3·10	4·44	5·18	3·41	6·71	5·54	4·72	47·08	Ditto for 1849.
5·68	7·31	10·92	12·22	9·31	20·37	17·72	17·39	141·64	Ditto.
1·81	3·27	4·10	3·51	2·57	3·92	2·97	2·44	33·58	Phil. Mag.
1·70	2·15	2·25	3·09	2·59	5·23	4·14	4·03	36·83	Ditto.
1·58	1·14	2·08	2·43	1·97	2·58	2·67	2·41	24·66	Trans. of Irish Acad.
1·89	1·81	0·83	0·95	3·01	4·96	3·94	2·60	29·08	Ditto.
0·99	2·40	6·37	2·27	2·67	3·63	3·62	1·83	35·56	Ditto.
2·25	2·12	2·65	3·16	2·51	3·88	5·0	5·21	40·27	Mr. Cunningham, Roy. Cork Inst.

[*Place between pages* 14 & 15.

tity of rain falls than is desirable for the perfection of the grain-crops, but not more than is requisite for the roots, which in these months require moisture for a rapid growth. November stands prominently out as a very wet month in Devon and Cornwall, but it has not this extreme character further eastward, and does not in Ireland show any excess of moisture over December.

36. The autumnal rain sets in earlier around the Cumberland hills, and judging from Swansea on the Welsh mountains also: in these districts October is the wettest month. The greater evaporation which takes place in summer is carried chiefly into the higher regions of the atmosphere, but the rain-clouds descend to a lower altitude on the approach of winter, and are at this season, when evaporation is still rapidly proceeding, placed more fully within the influence of the condensing power of these high lands. The excess of rain in October on the Cumberland hills, is the result of a law which is generally applicable to the most elevated districts of these islands.

37. More rain falls on the low lands of the eastern coast in summer and autumn than in winter and spring. This is shown by the excellent series of observations made at Boston.

38. The general result of what has been stated under this head shows, that there is a gradual change in the distribution of rain amongst the various seasons from west to east. On the south-west of Ireland and at Cork, the largest amount is deposited in the winter months; on the western coast of England and Scotland autumnal rain prevails; and on the eastern parts of England the summer months receive the greatest proportion of the annual quantity.

39. *Rain on elevated Regions.*—In the year 1793, Mr. Garnett reported to the Irish Academy that 84 inches of rain fell in one year at Kendal; since which 86 and 90 inches have been measured at Esthwaite Lodge and Grasmere. "So startling did these amounts appear to meteorologists when first made known, that many were led either to doubt their authenticity, or to suspect the accuracy of the instruments employed." These doubts have been effectually removed by the accurate observations and indefatigable labours of Mr. J. F. Miller, of Whitehaven, who has measured the quantity of rain which falls on the lake districts of Cumberland and Westmoreland, the results of which are published in the 'Transactions of the Royal Society for 1849.' From this source the table at page 16 has been compiled.

40. These observations of Mr. Miller are of great importance, in endeavouring to form a correct estimate of the climate of the British Isles; as a strong analogical case may be founded on the facts which he has established, applicable to all the high lands of

TABLE VI.—Showing the Annual Fall of Rain on the Lake District of Cumberland and places contiguous.

	Place.	Mean of Years.	Height in Feet.	The Mountain Gauges for 21 Months.	Annual Amount in Inches.
1845 1846 1847 1848	Whitehaven	4	90	. .	47·1
	Cockermouth	4	. .	. .	48·5
	Keswick	4	258	. .	63·6
	Gatesgarth	4	326	. .	121·4
	Seathwaite	4	. .	. .	146·4
	The Valley Seathwaite . .	21 months	242	223·64	127·8
	Wastdale Valley . . .	,,	160	170·55	97·5
	Sparkling Tarn	,,	1900	207·91	118·8
	Top of Stye-head Pass . .	,,	1290	185·74	106·1
	Summit of Sea Toller . .	,,	1334	180·23	103·
	Summit of Sca-fell * . .	,,	3166	128·15	73·2

the western coast. The whole of the north-west of Scotland and all Wales (except Swansea) have hitherto furnished few, if any, meteorological records.

The observations taken on and near Dartmoor tend to confirm this view. In the year 1841 72 inches of rain fell at Princetown on Dartmoor, at an elevation of about 1500 feet. At Tavistock, on the western side of these hills, the yearly average is 53·6 inches; and observations made at Good-a-moor, under Dartmoor on the south, give 57·5 inches for the annual mean. Thus the same general effect is produced as by the Cumberland hills. It is, therefore, highly probable that the intervening high land of Wales (which in geological structure and altitude is similar to the mountains of the lake district) receives the same abundant supply of rain. The geographical outline of the country appears in favour of an increased quantity on the Welsh hills. The rain-clouds from the Atlantic yield many a passing tribute to the Irish hills before they reach the Cumberland mountains; but Wales is quite exposed on the south-west to the ocean, and the clouds reach the hills with their contents undiminished.

The Western Highlands of Scotland are also similarly situated with respect to the sea, nor can it be inferred that a more northern latitude would much decrease the quantity of rain, for on the iron-bound coast of Norway, at Bergen, from 80 to 90 inches falls annually. The numerous rivers and lakes of Scotland, and the destructive land-floods which have occasionally occurred, show that large quantities of rain fall on the hills.

The Kerry mountains in the south-west of Ireland rise to an altitude of above 2000 feet,† and are fully exposed to the moist winds of the Atlantic; as far inland as Limerick and Toomevara,

* Highest point in England.

† Mangerton near Killarney is 2552 feet high.

the rain amounts to 35 and 40 inches annually: a much larger quantity, no doubt, falls on the high lands. Thus the romantic lake districts of Cumberland and Killarney have not only a common geological structure and origin, but are abundantly supplied with water from the concurrence of the same causes.

41. These hills have also a general south-west range, so that the valleys are longitudinally open to the rain-clouds, which favour an increased fall of rain on the low lands. Wastdale and Seathwaite are examples of the effects produced by this arrangement. In respect to Cumberland Mr. Miller remarks that, "The mountains flanking the lake district valleys generally increase in altitude with great regularity towards the head or eastern extremity of the vale; and it is here the greatest depth of rain is invariably found. The difference in the annual quantity between places contiguous to each other, and in the same valley, is often remarkably great. The amount increases rapidly as we recede from the sea, and towards the head of the valley the incremental ratio is enormous. Loweswater, Buttermere, and Gatesgarth, in the same line of valley, are about two miles apart from each other; yet in 1848 Loweswater has received 76 inches, Buttermere 98 inches, and Gatesgarth 133½ inches of water. Here, in a space of four miles, we have a difference of 57 inches in twelve months, and in some years the proportional excess is still greater."*

42. It is observable that the rain-clouds, on approaching mountain bosses, discharge a large portion of their contents before they actually reach the hills, so that the low land at the foot, and the valleys on the west and south of the hills, often receive a larger quantity of rain than the higher ground. Gatesgarth, Seathwaite, and Wastdale lie at moderate elevations, yet they receive enormous quantities of rain. Tavistock and Goodamoor, at the foot of the Dartmoor hills, are also remarkably wet places.

43. From the results obtained by the mountain gauges, and from observations made by the hygrometer, Mr. Miller infers that "the humidity increases upwards from the earth's surface, and that the condition, or combination of conditions, most favourable for the condensation and precipitation of vapour in the greatest abundance does obtain somewhere about 2000 feet above the sea-level."

The effect produced by the elevation of the land on the fall of rain may thus generally be stated:—

From the sea at Whitehaven to the wettest part of the Cumberland Lake district, the annual quantity increases from 47 to 146 inches.

From the lands at an altitude of about 300 feet in Cornwall to

* Transactions of Royal Society, 1849.

about 1500 feet on the Dartmoor Hills, the yearly amount rises from 44 to 70 inches.

At Kinfauns Castle, Scotland, 140 feet high, 25 inches falls annually; on an adjoining hill, 600 feet above the sea, the quantity deposited is 41 inches.

44. The number of days on which rain falls during the year is greater on the western than on the eastern coast, but the difference is not such as the relative quantity of rain would lead us to expect. The fact appears to be that the rain-clouds brought by the south-west winds, though partially drained by the western hills, yet pervade every part of England, and deposit much of the residue of their moisture on the eastern lands.

If as much rain fell on the heavy clay lands of England as on the friable soils of the western hills, the most productive wheat soils would be comparatively barren; but these hills form a natural system of atmospheric drainage, drawing from the clouds that superfluous moisture which would be injurious to the heavy land. The annual quantity of rain is however almost as widely distributed through the year on the eastern as on the western coast. This will appear from the following table. The greatest number of rainy days in the year no doubt occur in the south-west of Ireland, but I have not been able to obtain any recorded facts from thence on this point:—

Table VII.—Showing the Number of Days in the Year on which Rain fell at the places mentioned:—

Western Coast.		Eastern Coast.	
Whitehaven	175	Durham	148
Liverpool	178	York	181
Stoneyhurst College	195	Derby	190
Cumberland Lake District	210	Saffron Walden	184
Dublin	200	Aylesbury	154
Pool Cottage, Hereford	138	London, neighbourhood of	178*
Exeter (mean of 9 years)	175		
Truro (mean of 10 years)	177		
Helston	183		

On the Cause of the peculiar Character of the Climate of the British Isles.

45. So far as this investigation has proceeded, it shows that the climate of the British Islands is of a peculiar and anomalous character. The remarkable mildness of winter for the latitude, with the strange distribution of heat at that season—a more than tropical quantity of rain in some parts, with a change from west to east in the relative amount apportioned to the different seasons—all tend to show that the primary constituents of climate are

* Mean of 20 years by Howard.

greatly modified, or rather overcome, by secondary causes. On the American coast, the isothermal line of 41° is found in latitude 44°. Tracing this line eastward, it appears thrown up in a loop far to the north of Scotland, and cuts the coast of Norway in latitude 64°—the same mean temperature occurring on the European coast, 20° further north than on the American.

46. The isothermal zone, between the lines of 41° and 50° of mean temperature, on the coast of the New World, is about 300 miles wide; on the shores of the Old World its width is extended to 1100 miles, and within the warmest part of this unexampled extent of nearly similar temperature lie our favoured isles. It is a problem more important than curious to solve the cause of this peculiarity of climate, for the nature of the effects produced can only be clearly understood when their origin is ascertained. This inquiry will not therefore be based upon any ingenious theory, but upon the existence of well-established facts.

47. After a careful consideration of the facts which bear on this intricate subject, the only consistent solution appears to be, that the peculiarities of our climate are caused mainly by the two great currents of the North Atlantic Ocean—the Arctic current sweeping away the enormous quantities of loose ice of the frigid zone to the American coast, so screening us from the rigour of the frozen north; and that mighty ocean river, the Gulf-stream, bringing to our shores the heated waters of the torrid zone.

48. I have made an attempt to arrange and combine the leading facts which bear on this subject in the chart which accompanies this essay. The temperature of the sea is deduced from the numerous thermometrical observations of Humboldt, Fitzroy, King, Sabine, Lawson, and other sources. The position of the isothermal lines is fixed by Dove's Tables of Temperature.

49. The Arctic current originates in the sea on the north of Europe, and runs from Spitzbergen across the upper part of the Atlantic to the coast of Greenland; passing between that country and Iceland, it rounds Cape Farewell, sweeps the western coast of Greenland to the 67° of latitude; from thence it turns west and south along the shores of Labrador and Newfoundland, where it is lost in the waters of the Atlantic. The breadth of this current is in some places from 250 to 300 miles. Its velocity varies, in some parts of its course, from 8 to 16 miles per day. The icy masses it bears along are supposed to be about two months in making the circuit from Cape Farewell to the coast of Labrador. Immense fields and bergs of ice are annually borne southward by this current. Along the coast of Greenland, they are found to extend from 200 to 300 miles from the shore, marking the width of the stream. A continuous line of polar ice extends throughout the course of this current from Iceland to Newfoundland. In

1817, a large continent of ice on the north of Iceland, having an area of many thousand square miles, was suddenly broken up, and carried by the current southward into the Atlantic, where immense quantities were found on the south-east of Newfoundland, none of which drifted nearer the British shores than the 32° of longitude. In 1841, the Great Western steamer, in her voyage to New York, encountered a field of ice extending 100 miles in one direction, surrounded by innumerable floes and bergs.

A large proportion of the ice brought southward by the Arctic current is in the form of immense icebergs, which have their birth on the shores of Spitzbergen and Greenland. The hills of "Plutonic" rock along the sea-coast have their elevated and inclined valleys filled with enormous glaciers, which, by a gradual but sure process, travel onward to the sea, and are ultimately broken off and set afloat as icebergs. Captain Parry measured a berg in Baffin's Bay 4169 yards long, 3869 yards wide, and 51 feet high, being aground in 61 fathoms of water. An iceberg examined by Captain Graah on the east coast of Greenland, rose 120 feet out of the water, and its solid contents were estimated to be upwards of 900,000,000 cubic feet. Icebergs are often so numerous that Captain Scoresby counted 500 from one point of view.

50. The northern origin of the Arctic current, and the ice with which it is continually loaded, give it a temperature of 16° or 18° below that of the adjoining ocean; and at its southern termination on the great bank of Newfoundland, the water is 25° colder than the contiguous sea, and 33° lower than the Gulf-stream, with which at this point it comes in contact.

The cold surface of the water and the exposed parts of the ice materially affect the surrounding air. On ships approaching an iceberg, the thermometer falls 15 or 20 degrees. A good illustration of this fact is afforded by the different amount of heat on the north and south coasts of Iceland—the Polar current flowing along the north, and some of the warm drift-water of the Atlantic reaching the south coast. Here, in a distance of 100 miles, the difference of mean temperature is 8°.

51. The distance between the southern extent of the ice in the North Sea in summer and winter is about 140 miles, and that along a margin of 900 miles: thus on an average of years 126,000 square miles of ice are broken up each summer from this part of the sea, and drifted southward into the Atlantic, where it is caught by the current which has been described, and swept to the shores of Greenland and America. Now let us suppose that this current, instead of protecting the British Isles, flowed southward from Spitzbergen along the coast of Norway. It would convert Scotland into another Labrador, and her skilful agriculturists into seal-

hunters and fur-dealers; but happily her shores are washed by a more genial sea.

52. The water of the South Atlantic has a general movement westward to the Gulf of Mexico, into which also the Guiana current flows. Here entangled and confined, the water becomes heated as in a cauldron to a temperature 4° above that of the sea under the equator, and 8° above the Atlantic in the same latitude. The overflowing of this accumulation of warm water gives rise to the *Gulf-stream.* The stream is first perceptible on the north-west of Cuba, where it flows weakly to the east; but, owing to the narrowness of the straits of Florida, it rushes with great velocity through this channel, runs north and north-east along the coast of the United States to Cape Hatteras, from thence it inclines more to the east, brushes the southern extremity of the banks of Newfoundland, and runs eastward across the Atlantic to the Azores.

53. The high temperature of the Gulf-stream in all parts of its course is one of its striking peculiarities. It leaves the Gulf in summer at 86°—near Cape Hatteras the thermometer shows 81°, or from 10° to 12° above the water of the ocean under the same parallel, hence to 43° of longitude the thermometer falls to 75½°, and at the Azores to 72½°; still preserving a temperature of from 8° to 10° above that of the ocean.

The Gulf-stream, and its widely-extended overflowing, form a body of warm water of great extent in the middle of the Atlantic. Its length from west to east exceeds 2000 miles, and its breadth may be taken at a mean of 360 miles; this gives an area equal to four times the extent of France, and larger than the Mediterranean Sea. The prevailing south-west wind has its origin in this part of the Atlantic; its peculiar mildness and humidity being derived from the warm current over which it sweeps.

54. Thus far the acknowledged course and character of the Gulf-stream have been described; I shall further show that a large portion of this accumulation of warm water continues to flow in a north-east direction along the western shores of these Isles and the coast of Norway.

Major Rennell has established the existence of a current, which flows east from the Atlantic along the north coast of Spain, and by the shores of the Bay of Biscay to the Scilly Islands and St. George's Channel. Dr. Franklin found the temperature of the Bay of Biscay in November, 1776, to be 60°.

An arm of the gulf stream leaves it in lat. 45°, long. 30° W., and runs in a north-east direction towards the coasts of Europe, and becomes very strong during a continuance of south-west wind. It has been marked on some charts as a "drift current," though it more properly forms a necessary part of a system of continuous

ocean streams, by which one current feeds another, or compensates for the drainage it effects. By this current plants, seeds, and trees, which belong to the torrid zone of America, are annually cast on the western coasts of Ireland, Scotland, and Norway. In the Museum of the Highland Agricultural Society there is the trunk of a palm-tree which, some years ago, was cast on the shores of Argyleshire. In June, 1819, the British ship "Newcastle" threw a sealed bottle into the gulf stream on the south of Nova Scotia; it was afterwards found in the Frith of Clyde (Rennell). Captain Sabine states that casks of palm-oil, which had been lost by shipwreck at Cape Lopez, were carried onward first by the equatorial current, and then by the gulf stream to the coast of Scotland.* The wreck of the ship "Tilbury," which was burnt near Jamaica, was drifted by the stream from thence to the Scottish coast.

The indraught of St. George's Channel is well known to all mariners; at the Scilly Islands the flow of the tide from the south-west continues for eight hours, whilst the ebb in a contrary direction is only about four. In other words, the current overcomes the tide.

55. The temperature of the sea on the north of the British Islands is remarkably high for the latitude. In the month of May it is 47°·6 at the Faroe Isles, whilst on the same parallel on the coast of Greenland the thermometer falls to 34°.†

The effects produced on the coast of Norway by the warm water of this current are most obvious and instructive. The stream strikes the coast about the latitude of Bergen: on the south of this point snow often lies along the shore, when it has wholly disappeared further north. It is a well known fact, that during the winter months the heat *increases* as you pass *northward* on part of the Norwegian coast; and the general temperature is so mild for the latitude, that barley can be grown nearly up to the North Cape. And even as far north as Bear Island, lat. 75°, south-westerly winds are accompanied by mild weather; the months of November and December usually bring rain, but no snow, and the taking of the walrus can be continued even till Christmas. Whilst Melville Island, in the same latitude, is one of the coldest spots on earth, having a mean temperature 31° below the freezing point.

The curves in the isothermal line of 41° correspond with the effects which these currents produce. This line is bent to the south by the cold waters of the Arctic Ocean; and under the influence of the Gulf-stream it is thrown up in a sharp curve far to the north of the Faroe Islands.

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* Edin. Phil. Jour., No. VIII., p. 182. † Ibid., Oct. 1848, p. 289.
‡ Ibid., Oct. 1848, p. 291.

56. A review of the facts which have been thus shortly stated leads irresistibly to the conclusion, that much of the peculiarity of our climate is produced, not by the ordinary effects of oceanic influence, but by the vast movements of the sea, which have been described. It is therefore no flight of fancy to assert, that we are indebted to the continuous mountain chain of the Andes for our agricultural position and prosperity. Let the Isthmus of Panama, which now intercepts and diverts the Equatorial current, be wholly swept away, and it would produce a greater revolution in Britain than arms or science ever effected.

57. It is found that the air over the sea has a mean temperature of about 2° below that of the surface-water. Captain Sabine remarks, that "*the temperature of the air is known to be immediately dependent on that of the surface-water of the sea, and to be influenced nearly to the full extent of any alteration that may take place therein.*" In the Gulf of Guinea the temperature of the water and the air was changed by the currents in a few days' sail as follows:—

	Mean of Sea.	Mean of Air.
The Guinea current . . .	83° . . .	81°·5
The Equatorial current . .	73 . . .	74 *

58. In order to determine the effect of the sea on the climate of the western coast in winter, I have had a register kept of the temperature of the surface-water of the sea at St. Agnes, an open, exposed part of the north coast of Cornwall, and the following are the results deduced from 146 observations:†—

	Oct.	Nov.	Dec.	Year.
	°	°	°	
Mean temperature of the surface water of the sea .	54·8	53·5	50·3	1849
Mean temperature of the air at Roy. Inst., Truro .	52·9	49·6	42·9	1849
Excess of temperature of the sea above the air	1·9	3·9	7·4	

From these observations it appears that the warmer waters of the sea must, in the depth of winter, considerably influence the temperature of the adjoining air. In the month of December the sea is ordinarily 6° above the air, but, in consequence of the frost in that month last year, the excess amounted to 7°·4. During the continuance of the frost, the thermometer in the air sunk to 20°, when the lowest temperature of the sea was 46°. It is therefore not surprising that snow never lies along the coast, and that frost is of short continuance.

The difference in the temperature of the sea-water at day and

* Phil. Mag., June, 1826, p. 428.

† For detailed observations, see Appendix No. 2.

by night was scarcely perceptible, an occasional variation of $1\frac{1}{2}°$ might be observed; but on the tidal-water of the Fal, twelve miles from the sea, I found the difference on clear days to be from 2° to 4°.

It is known that the sea-water becomes colder on nearing the land,* deep water being the warmest at the surface; and the thermometer showed at St. Agnes a somewhat higher temperature on a flowing tide than on the ebb. The full effect, therefore, of the Atlantic on the climate of the western coast is somewhat greater than these observations indicate.

59. The Transactions of the Royal Society for 1849, part ii., contain the thermometrical observations made at the apartments of the Society from 1774 to 1843, reduced and arranged by Mr. Glaisher. From Table III. it appears that great variations have taken place in the January mean temperature: in 1795 it was below the average 11°·7; on the following year it was in excess 9°·7; making a difference of 21°·4. These extraordinary winters were followed by a great diminution of heat in July, with defective harvests; and corn rose to very high prices. The following table gives a condensed view of these interesting facts:—

Year.	January: Variations from Mean.	July: Variations from Mean.	Price of Corn per Quarter.†	
	°	°	s. d.	
1794	− 2·3	+3·9	52 3	
1795	−11·7	−2·5	75 2	Very bad crop of wheat—a year of dearth. Many of the poor died of want.
1796	+ 9·7	−2·8	78 7	
1797	+ 0·2	+1·9	53 9	

Captain Sabine, in a voyage to Madeira in January, 1822, found an excess of temperature in the water of the Atlantic of from 3° to 6°; and he attributes to this fact the peculiar mild character of that winter. Mr. Daniell, in his 'Essay on the Climate of London,' says, "November, 1821, differed from the mean and from both the preceding years in a very extraordinary way. The average temperature was 5° above the usual amount; the quantity of rain exceeded the mean by one-half: all the lowlands were flooded, and the sowing of wheat was very much interrupted by the wet.—In December the mild temperature pushed forward all the early sown wheats to a height and luxuriance scarcely ever before witnessed. The grass and every green production increased in equal proportion.—January, 1822. This

* Phil. Mag., vol. lxvii. p. 339. † Parl. Return, March 23, 1843.

most extraordinary season still continued above the mean temperature; fears were entertained lest the wheats should be more productive in straw than corn.—The month of February, still 5° above the mean temperature." *

60. In 1845 the 'Clyde,' in her voyage to Barbadoes, found the temperature of the water near the Scilly Islands as warm as it usually is off the coast of Portugal.† The succeeding autumn months at Truro were exceedingly mild, and the following January and February were 6° above the average temperature.

It is known that the water of the Gulf-stream is warmer, and flows with greater velocity in some years than in others, which is the most probable cause of the great variations which occur in our winter temperature, and a mild winter is generally accompanied with much rain.

61. *Amount of insensible Vapour: Mists—Fogs—Clouds.*—The great humidity of the atmosphere of the western coast of England and Ireland, has been much commented on by every writer on the climate of these parts, and in most agricultural surveys it forms the standing topic of remark; as if nothing further were required, "climate very mild and humid" appears to have been thought a sufficient description for that of Ireland, Wales, and half of England. But when we come to examine the quantity of moisture contained in a given space of atmospheric air, and compare it with that of the eastern coasts, we are surprised at the small difference which the most accurate observations show. The following table is compiled from the quarterly returns of the Registrar-General for 1848.

Table VIII.—Showing the Mean Weight of Vapour in Grains in a Cubic Foot of Air for every Month.

Place.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
Greenwich Observatory .	2·2	3·0	2·9	3·1	3·9	4·3	4·8	4·5	4·2	3·8	3·0	3·1	3·2
Latimer Rectory, Bucks	2·3	3·5	3·0	3·3	4·4	4·7	5·1	4·7	4·1	4·0	3·0	3·1	3·5
Aylesbury	2·4	3·0	3·0	3·3	4·6	4·9	5·2	4·8	4·2	3·9	2·8	3·0	3·4
Saffron Waldren . . .	2·3	3·0	2·9	3·6	4·9	5·3	5·9	5·3	5·4	3·4	3·0	2·9	3·5
Cardington, near Bedford	2·3	3·0	3·1	3·4	4·5	5·0	5·3	5·0	4·8	4·1	3·1	3·1	3·7
Norwich	2·3	2·9	3·2	3·6	4·3	5·0	5·3	4·8	4·7	4·1	2·9	3·0	3·5
Derby	2·5	2·8	3·0	3·1	4·5	4·6	5·2	4·9	4·6	3·9	3·1	3·1	3·4
Highfield House, Notts.	2·4	2·9	2·9	3·0	4·2	4·5	4·9	4·5	4·1	3·8	2·9	2·9	3·1
Liverpool Observatory .	2·4	3·1	3·0	3·2	4·1	4·3	4·8	4·4	4·4	3·7	3·1	3·0	3·4
Durham	2·3	2·7	2·8	0·5	1·3	1·0	4·5	4·1	4·0	3·5	2·7	2·9	2·3
Whitehaven	2·3	3·1	3·0	3·3	4·1	4·4	4·9	4·4	4·4	3·7	3·1	3·0	3·5
Newcastle-on-Tyne . .	2·4	3·1	3·1	0·4	0·9	0·6	4·9	4·4	4·4	3·9	3·1	2·9	2·4
Helston	2·6	3·5	3·2	3·5	4·3	4·6	5·2	5·0	4·7	4·0	3·4	3·7	3·6

By comparing Helston with Greenwich, and Whitehaven with Durham in this table, it will appear that the atmosphere of the western coast is the most humid, and that the relative difference is greater in the north of England than in the south. The figures

* Phil. Mag., June, 1826. † Edin. Phil. Jour., Jan. 1846.

do not, however, precisely represent the comparative dryness of the air at the places named, in consequence of the greater amount of vapour which the air is able to sustain at a higher temperature. The difference in July between Helston and Greenwich is given as 5·2 to 4·8 grains; but in consequence of the higher temperature of the latter place in July, the air is much less charged with vapour than the figures represent. With this general correction, which will not materially affect the results, especially as showing the mean of the year, the table gives the hygrometric condition of the air at the places mentioned.

62. But again; the greater dryness of the air of the eastern counties must necessarily result from the daily range of the thermometer being greater there than on the western coast. Dryness depends on cold nights preceding warm days; the low temperature of the night air causing a precipitation of moisture, which the ordinary evaporation cannot readily replace, and the returning heat of the day is combined with a dry clear atmosphere. Let us apply this rule to two places on the opposite sides of England, and it will furnish results which may be relied on when not violated by accidental causes.

A mean of ten years at Truro gives 65°·6 for the temperature of a July day, and 52° for that of the night; then—

Vapour sustainable at 65°·6	=	·629 inches.
Ditto ditto at 52°	=	·400 ,,
Dryness, or capacity for additional vapour . . .		·229 inches.

A mean of the same ten years at Chiswick gives 72°·8 for the day, and 51°·7 for the night in July:—

Vapour sustainable at 72°·8	=	·800 inches.
Ditto ditto at 51°·7	=	·395 ,,
Dryness . .		·405 inches.

In the winter months the difference between the humidity of the air at these places is in a much lower ratio.

Truro, in January, vapour sustainable at 46°·3	=	·330 inches.
Ditto ditto ditto at 39°·4	=	·260 ,,
Dryness, or capacity for additional vapour		·070 inches.

Chiswick, in January, vapour sustainable at 43°·1	=	·294 inches.
Ditto ditto ditto at 31°·24	=	·194 ,,
Dryness		·100

Thus between Truro and Chiswick the dryness in the warmest month is represented by ·229 and ·405; and the coldest month by ·070 and ·100.

63. But apart from instruments, we can judge of the dryness of the air by its effects. In the west of England a floor of stone flags is as often found with a wet, as with a dry surface; and harness which has been laid by for a few days becomes covered with moisture. "The worst circumstance of the climate of Ireland (says Arthur Young) is the constant moisture without rain. Wet a piece of leather, and lay it in a room where there is neither sun nor fire, and it will not, in summer even, be dry in a month." The mild temperature of Ireland, and the great humidity of the air acting on an open rich limestone soil, wonderfully promote vegetable growth. The lowest degree of heat is not sufficiently cold to check the progress of the natural herbage; nor the highest summer temperature in general powerful enough to parch the surface of the moist soil; hence the land is clothed with constant verdure, and merits the characteristic name which it has obtained—"The Emerald Isle."

Our ordinary sensation and feeling is a good test of humidity. In the dry atmosphere around London I have found the system braced and strengthened. In the midland counties, especially Northampton, there is a delicious feeling of pureness and freshness in the air, which makes you inhale it with the same delight as that with which the Hindoo drinks the water of the Ganges. But on the Western shores the constant moisture relaxes the frame, the night air is cold and murky, and the chilly feeling produced, is scarcely overcome by the adoption of two evils—the overcoat and wrapping-shawl.

64. *Mists.*—The moist wind from the Atlantic on approaching the western hills is driven up their slopes until it reaches a colder stratum of air, and if perfect condensation does not take place the vapour becomes visible, and a damp driving mist, mingled with some rain, is formed, which often continues for many days. Vegetation is everywhere loaded with moisture; each blade of grass, and each twig of the tree, has suspended to it a drop of water, which when shaken off by the wind is again formed. From this cause cattle-ponds on the summit of hills, when surrounded by trees, rarely fail of water. The soil also absorbs a large quantity of water which the rain-gauge does not measure. In cool summers these mists often set in before the harvest is commenced on the high lands, when the crops suffer severely, and there is little hope of saving them in good condition. Wales, the north of Ireland, and the north-west of Scotland are parts in which a late harvest is most injured from this cause.

65. *Fogs* are caused principally by the change of temperature in the 24 hours. The soil of the plains and valleys is heated by the sun during the day; evaporation and radiation of heat follow; on this warm moist atmosphere the cold air of higher

districts sinks by night, and the vapour becomes visible and forms a fog. The eastern counties and lands along the coast are more subject to fogs of this nature than on the western lands. In November, after the exhalations of summer, and when the chill nights of winter begin to appear, these fogs are the most abundant; the air sinks beneath the temperature of the dew-point, and vapour is immediately formed. The low marsh-lands adjoining the Wash, and the coast of Lincolnshire, being bordered by hills and open to the sea on one side, are much subject to fog. Such also is the origin and nature of the fogs in the valley of the Thames, on the lowlands of the Humber and Holderness, and on the north-east coast of Scotland, especially in Aberdeenshire, and from thence to Orkney.

66. On the western coasts the fogs are chiefly confined to the narrow valleys, which are often filled to a height of from 50 to 100 feet with a cold stratum of fog, which is drawn up by the morning sun. During the past winter I took a set of observations on the temperature of the water in the tidal part of the river Fal. I found that on cold nights when the temperature of the air fell below that of the water, a dense fog was formed along the valley; but when in the morning the air became heated to the same degree as the water, the fog gradually rose and was dispersed over the hills.

Along the north coast of Devon and Cornwall, in the summer of 1847, a heavy fog would roll in at night from the Atlantic and cover the land; on the return of day it would again recede, and might be seen hanging over the sea along the horizon throughout the day.

67. *Clouds.*—Mists and fogs are principally due to local causes, and affect peculiar districts, and like clouds are masses of visible vapour, differing only in their mode of formation. The vapours which so abundantly rise from the warm water of the Atlantic, become visible in the higher regions of the atmosphere, and are carried on by the prevailing south-west wind to these islands, in accumulated masses of heavy cloud. The north and north-east winds on the contrary generally bring a clear sky. As it was in the days of the earliest philosopher so it is now. "Fair weather cometh out of the North," says Job.

During rainy weather the clouds are but little elevated above the western lands, and may often be observed below the tops of the hills. After continued rain from the south-west for many hours I found that the temperature of the air was but 3° above that of the rain-water, giving a height of about 700 feet for the greatest amount of saturation.

In autumn and winter the rain-clouds are placed more fully within the condensing power of the western hills, by which they

are drained of a large portion of their moisture, and with diminished humidity and bulk they pass on to water the low eastern lands. Thus in Cumberland, and Cornwall, November is a very wet month; but at Chiswick, Boston, and Durham, less rain falls in November than in the summer months.

TABLE IX.—Showing the Mean Amount of Cloud for each Month at the places mentioned, in 1848, 0 to 10 (Truro and Exeter give the mean of 10 and 9 years, the other places are reduced by the mean thus obtained) :—

Place.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	°	°	°	°	°	°	°	°	°	°	°	°
Greenwich Observatory	6·6	7·6	5·6	7·3	3·0	7·4	6·6	7·6	5·6	7·3	6·7	6·7
Walworth	4·5	4·8	2·6	8·2	1·3	7·5	4·5	4·8	2·6	..	..	..
Aylesbury	6·7	7·1	4·5	6·8	2·3	8·5	6·7	7·1	4·5	7·3	5·7	7·4
Saffron Waldren . .	4·7	5·4	3·9	6·3	2·7	6·0	4·7	5·4	3·9	4·9	5·7	5·9
Leicester	5·5	5·9	4·5	8·1	2·2	7·0	5·5	5·9	4·5	6·5	5·5	7·0
Durham	5·7	5·5	6·2	6·3	1·4	6·8	5·7	5·5	6·2	7·3	5·4	6·7
Stoneyhurst College .	7·7	7·1	7·4	7·1	5·4	7·8	7·7	7·1	7·4	7·2	7·0	7·7
Liverpool	7·0	6·4	6·7	5·6	3·7	8·5	7·0	6·4	6·7	6·9	7·1	7·0
Southampton . . .	6·0	7·0	7·0	7·0	2·5	7·3	6·0	7·0	7·0	6·0	6·5	7·0
Exeter	4·2	4·6	4·1	2·8	1·0	3·5	4·2	4·6	4·1	4·4	5·0	6·0
Truro	6·2	6·8	5·8	6·5	2·4	7·1	6·2	6·8	5·8	6·7	7·5	7·5

The table shows a greater amount of obscuration for the eastern land than is generally supposed to prevail; but the clouds are there found at a higher altitude, and less affect the surfaee soil. May month is remarkably open and unclouded, so that the spring crops receive much benefit from the solar ray, when light, heat, and moisture are required to promote a rapid growth. The cloudy state of the western sky materially prevents the radiation of heat from the soil during the night, so that warm close nights, without any deposition of dew, often occur; this leads to the consideration of

68. *Dew.*—In a calm clear night the radiation of heat from the soil is so rapid that the surface of a grass-plot is often 10° or 15° cooler than the air a few feet above it. The lower stratum of air which immediately rests on the grass is cooled down below the dew point, when its excess of moisture is deposited on the herbage.

My observations show that, in September and October, 1849, the warm cloudy nights in the south-west of England were accompanied with very little dew, on some mornings the grass was quite dry; but with a calm night, and a clear sky, the dew was most abundant. On the eastern coast the clearer nights and the greater diurnal range of the thermometer tend to produce a larger deposition of dew.

Dr. Dalton estimates the annual deposit in this country to be 5 inches, or about 22,000,000 of tons.

69. *Hoar-frost,* the ice of dew and mist, is formed when the temperature of the lower stratum of air, which rests immediately

on the soil, sinks below the freezing-point. The air on the surface is often 6° or 10° * colder than that 4 feet above the ground; the greater weight of the cold stratum causes it to sink into the hollows of the fields and the valleys; and it is in these situations in calm clear nights that hoar-frost is most destructive.

In the south-west of England hoar-frost is most injurious in the spring to the early vegetables, the grass, the barley, and the fruit-blossoms. On the north-east of Scotland the potatoes suffer in the latter part of the summer before they are ripe.

The early vegetable productions near Penzance need to be guarded from the effects of hoar-frost, which is there found more injurious than ordinary frost. The most usual preventive is a light covering of straw. It is also common to kindle a fire to windward, that the smoke may pass over the crop; the current of air thus produced has more influence than the heat of the fire or smoke, for a free and open circulation of air is the best preventive against hoar-frost.

During the past December (1849) hoar-frost for several nights in succession was most abundant on the grass-plot before my house. The constant change from frost to thaw injured and cut the tender garden-plants, and the grass drooped under the effects produced. On holding a blade of grass between my eye and the sun, I perceived that the sap-vessels were in many places ruptured, which was shown by a dark-green spot; in a few days these spots turned yellow, and a dry wind setting in, the top of the blades withered and died.

Thus in order to get an early piece of pasture in the spring the grass should be protected during the continuance of cold nights. A light covering of straw, or fibrous dung, would prevent the radiation of heat into space, and protect the tender shoots from hoar-frost, so as to fit them for rapid growth under the influence of a clear spring sky. There can be no question that this is the mode in which the much lauded "fibrous covering" acts in promoting vegetable growth, rather than by exciting electrical action. The results of Dr. Fyfe's experiments on electro-culture show, that the application of electricity to vegetation was followed by no benefit whatever.†

70. Cattle lying on low lands on a clear night, are exposed to a severe and injurious amount of cold: it is probably for this reason that sheep prefer to lie on the most elevated ground, or on a bank. Cattle hemels in this point of view, however rough, are highly favourable to health and growth.

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* On the 19th August Dr. Wells found the air on the ground at 6h. 45m. 7½° colder than that 4 feet above the surface; at 8h. 45m. the difference was 12°.

† Edin. Phil. Jour., Oct. to Dec. 1845, p. 153.

To guard against cold damp air, farmhouses, yards, and sheds should be built on gently-sloping sheltered eminences. Gardens where early vegetables are desired, should be situated on ground sloping to the south, with a low fence, or still better, a ditch as the southern border; a wall for fruit on the other sides; the cold stratum of air on the surface would then pass down the slope and be replaced by air 4° or 6° warmer; a circulation so produced would greatly protect the plants from injury by hoar-frost.

71. *Winds.*—The temperature and weather of the British Isles are greatly influenced by the direction of the wind. On the south and west lies the Atlantic, sustaining on its bosom a reservoir of humid air. On the east lies the cold air of the Alps, or the dry air of the great northern plain, whose surface is covered with drift and gravel. On the north are the high bleak mountains of Scandinavia, covered with snow for half the year. When the wind blows for a few days in one direction it covers this land with the atmosphere of the region which it has traversed, and impresses its distinctive character on our climate; in fact the wind makes the weather. The general direction of the wind is shown below; the effects produced will be described further on.

TABLE X.—Showing the General Direction of the Wind.

Place.	Years.	N.	S.	E.	W.	S.W.	N.W.	S.E.	N.E.	Number of Observations.	Authority.
London . . .	10	16	18	26	53	112	50	32	58	365	Royal Society.
Lancaster . . .	7	30	51	17	47	92	26	35	67	365	
Dumfries . . .	9	36¼	38½	68	69	50½	25½	18½	14½	321	
Londonderry . .	7	32	42	29	109	68	53	77	32	442	M'Culloch.
Truro	6	63	67	90	129	173	162	114	82	880	Report Cornwall Royal Institution.
Bowerhope, Selkirkshire . .	10	15	28	40	71	101	35	16	22	328	
Cambuslang, near Glasgow . .	7	..	..	..	..	174	40	47	104	365	Dr. Meek.
Exeter	10	..	..	..	..	173	188	123	115	599	Dr. Barham.

At Cork Dr. Smith states, that "it appears from a regular diary of the weather kept for several years in that city, that the winds blow from the south to the north-west three-fourths of the year at least."

72. *General effect of the Climate of the British Isles on Vegetation.*—The thermometrical distribution of heat which has been described, with the variable quantity of moisture which the soil in different localities receives, and at different seasons, must produce a corresponding effect on vegetation; and this effect is more evident in plants whose distribution is governed by natural laws, than in those which the skill or the wants of man have taught him to raise in situations not always adapted to them.

Thus in the warmest region of these islands, and where the highest winter temperature exists—on the south-west of Ireland—twelve or more species of plants occur in a wild state, which are natives of the north of Spain.

On the south-west of England and south-east of Ireland a vegetation exists intimately related to that of the coasts of Normandy and Brittany, and not found elsewhere in the British Isles.

On the elevated hills of Wales, Scotland, and some of the highest points of Ireland, the plants entirely differ from those of the low lands, and are analogous to the vegetation of Scandinavia, and the Alps. In the high regions of Scotland the grouse, the ptarmigan, and the Alpine hare are found in the several zones of temperature for which nature has fitted them.

The Germanic type forms the predominating vegetation of the kingdom, occurring alone or in common with groups of other plants. "All plants universally diffused in these islands are German." (Forbes.)

On the south-west coast of England greenhouse plants flourish with less care than in other places, and myrtles, geraniums, and other tender exotics are constantly exposed during the winter, and flower well the following summer. A considerable number of plants from New Holland, and New Zealand, were, as an experiment, forwarded by the late Mr. Aiton of Kew Gardens, to Penzance, where they have flourished in the open air for many years.

73. *Effect of Climate on the Growth of Corn.*—The production of bread-corn is a primary element of agricultural and national prosperity, and never was the question of the relative effects of elimate on the growth of wheat so important as at the present moment. Apart from all political and party considerations, this view of the case must force itself by its practical bearing on the corn-growers of this kingdom. I therefore feel that I am entering on a question which requires to be examined with the utmost care and impartiality, that theoretical inferences should be avoided, and no conclusions drawn but what well-established facts will justify. I have, therefore, with much labour, collected and arranged the Tables of Temperature, Rain, and Moisture, which accompany this essay. And most fortunately at this juncture the thermometrical observations made at the apartments of the Royal Society from 1774 onwards, have been reduced by Mr. Glaisher, and published in the last issue of the "Transactions" of the Society. The limits of this essay will only permit a very restricted use of these most valuable Tables; those who may desire further information on the subject will do well to consult these facts so admirably arranged by Mr. Glaisher.

74. Our corn-producing plants are exotics—natives of a warmer clime—their original locality cannot be clearly defined; but there is no doubt that these grains accompanied the progress of agriculture from Egypt to Greece, and were spread from thence over Europe. Wheat and barley have been found growing wild in Persia, Mesopotamia, and on the banks of the Euphrates; and a writer on this subject in the "Edinburgh Philosophical Journal" for 1827 arrives at the conclusion, "That the valley of the Jordan, the chain of Libanus, or the parts of Palestine and Syria which border upon Arabia, may with great probability be assigned to our cereals as their native country." These valuable grains have been spread over the temperate regions of Europe, where they are naturalized; and the hardy inferior varieties have been pushed as far north as the rigour of the climate will permit. In what part of this cereal zone are our islands situated? Certainly not in that best adapted for wheat, which is grown in greater perfection on the plains of Europe, and in the dry hot summers of Spain. The summer temperature of the cultivated lands of the British Isles varies from 54° to 64°; in the fertile plain of Lombardy it is 73°; and in Sicily, "the granary of ancient Rome," 77°. There is no part of Europe where the wheat crop is pressed into so low a summer temperature as in these islands, and that with a considerable degree of success. In 1727 a small field of wheat near Edinburgh was so extraordinary a phenomenon as to attract the attention of the whole neighbourhood; and up to 1770 its cultivation was little extended. But now abundant crops are seen on the lowlands, the most favourable hill districts are invaded, and the culture pushed as far north as the Murray Frith, from whence some excellent samples are sent to the London market. On the north of Ireland, where Mr. Wakefield thought it would be useless to introduce wheat, it is now extensively cultivated. We are, therefore, in a good position to determine the effect of climate on this grain, and to inquire how far the profitable cultivation of wheat may be carried, and what are the conditions of climate necessary to its perfection.

75. In order to obtain a condensed and comprehensive view of the effect of climate on the wheat crop, I have compiled from the meteorological observations of the Royal Society, from Tooke's 'History of Prices,' and from a Return made to the House of Commons in 1843 on the price of wheat, the following tabulated facts, giving only such years as were marked by peculiar abundance or deficiency. More minute details of these and other seasons may be consulted in the Transactions of the Royal Society:—

TABLE XI.—Showing the Effect of Temperature on the Wheat Crop.

Year.	Variation of the Temperature of the Season from the Mean of 65 Years.		Price of Wheat per Quarter.		State and Condition of the Wheat Crop.
	Spring.	Summer.	In Autumn following the Harvest.	For the Year.	
	°	°	s. d.	s. d.	
1775	+1·7	+1·2	43 7	49 10	Plentiful harvest.
1779	+4·3	+2·3	35 7	34 8	Season of great fertility, the crop one-fourth above a medium.
1789	−2·6	−2·	..	52 9	Very deficient crop.
1791	+0·2	−0·5	40 11	48 7	Abundant crop.
1792	−1·3	−1·6	..	43 0	Inferior harvest,—much injured by wet.
1795	−1·3	−2·2	80 0	75 2	Very defective crop, followed by a dearth, in which many of the poor perished.
1799	−3·8	−2·3	94 2	65 0	Wet, cold summer, much grain injured and destroyed.
1800	+0·1	+0·7	133 0	113 10	Bad crop, partly saved in England. In Scotland much corn did not ripen; destitution and famine followed. Much rain.
1809	−0·1	−1·3	102 6	79 4	Deficient crop; the rain set in in July, and continued till October. Wheat suffered from mildew and sprouting.
1810	−0·4	−3·7	97 4	106 5	Bad, scanty crop. Well got in.
1811	+2·2	−1·7	101 6	95 3	Five-eighths of average crop. High winds at blossoming time, and little sun and heat at harvest.
1812	−2·8	−3·8	155 0	126 6	Defective and bad crop. In Mark Lane, Dantzic wheat fetched 180*s.* per quarter; oats made 84*s.* A famine year.
1816	−2·7	−4·8	103 0	78 6	Great deficiency in quantity and quality. Heavy rain and stormy winds in July, until harvest. The crops on the Continent also very bad. A famine year at Paris.
1818	−0·2	+4·3	78 10	86 3	A remarkably dry, hot summer: no rain for four months from middle of May. Wheat an average crop in the eastern counties: very heavy and abundant in the west. Hay came from New York, and barley from Constantinople made 63*s.* 6*d.* per quarter.
1822	+3·4	+2·2	38 0	44 7	Full average produce; quality universally good.
1825	+0·4	+2·	64 0	68 6	Unusually early and promising harvest.
1826	+0·9	+4·	58 1	58 8	Remarkably early harvest; crop and condition very good. Very dry in the west, and crop excellent.
1834	+0·5	+2·5	40 6	46 2	A most productive harvest.
1835	+0·3	+2·6	36 0	39 4	Great bulk of straw, much laid by rain in June. On the whole, good crop.
1836	+0·1	+0·3	61 9	48 6	Medium crop in England. In Scotland very cold, with rain, in July and August. Crop remarkably backward; a portion never ripened.

From this Table the connexion between the temperature of summer, and the produce of the harvest is most obvious and instructive. An average amount of heat occasionally produced a good crop, as in 1791; but then experience shows that it must be accompanied by a dry season. In 1840, the summer temperature at Truro was 59°, or 1° below the mean, and not much above half the usual quantity of rain fell. A finer harvest since 1818 never occurred in the West of England; the wheat crop was above the average, and the yield excellent. But, though the harvest will succeed in England at an ordinary summer's temperature, or even at 1° below, other things being equal, Scotland is extremely sensitive to the least depression of summer heat, as shown by the effects of the summers of 1800 and 1836, when the wheat was saved in tolerable condition in England, while a large portion of the crop was completely lost in Scotland.

76. The table shows that a cold wet summer is followed by the most lamentable consequences; a deficiency of only 2° of heat falls with a withering influence on the harvest prospects, but when it amounts to 3° or 4°, dearth and famine follow in its train. Happily, this depression of temperature is of rare occurrence, for in a period of 65 years the summer temperature fell only seven times below the mean, from 2° to 3°; and only three times during these years did it fall lower than 3°—in 1810, 1812, and 1816. On the other hand, for the same period, the summer temperature rose above the mean eight times from 2° to 3°, and five times it exceeded 3°.

77. Those summers which have been more than usually cold have generally been accompanied by a large quantity of rain. In fact, the rain has rather been the cause than the effect of the low state of the thermometer. Such a season tends to produce a large amount of straw, which, on a continuance of damp weather, is peculiarly liable to be attacked by disease; hence in the wet years of 1809, 10, 11, much damage was done by mildew.

78. Turning our attention to the years when the summer temperature has been in excess, it is found that the abundance of the crop, and the perfection of the grain have almost invariably been of the most cheering character. An occasional high wind during the flowering time, or a sudden change of weather at harvest, may in some years have done injury; but, generally, the height of the thermometer is a good indication of the productiveness of the harvest.

These islands seldom suffer (in respect to the wheat crop) from an excess of heat, and it is of great national importance that a year of drought followed by deficiency scarce ever occurs. The year 1818 was that which approached the nearest to this

character, when no rain fell for four succeeding months; but even then, though the straw was remarkably scanty in the eastern districts, the ear was crowded with grain. In the south-western counties the crop was of the most abundant description; and I well remember the feeling of astonishment with which, on my father's farm, I viewed this crop with several friends, gathering the finest ears, and observing that five grains in a row on each side was almost universal—to use a common phrase, "it was kerned like peas."

79. The most important inference from this table is, that the summer temperature of these islands is, as a whole, within a very few degrees of the minimum temperature required for the perfection of wheat; a deficiency of 2° or 3° places the whole crop in the utmost jeopardy; almost invariably there results a great falling off in quantity and quality, which is most severely felt in Scotland, the north of Ireland, and in the west of England.

80. By consulting the tables in the 'Philosophical Transactions of the Royal Society' for 1849, arranged by Mr. Glaisher, especially Tables 3 and 7, it will appear that a succession of warm and cold summers occur in groups. The sign of plus (+), by which the excess of heat is indicated, is distributed over the page like clusters of stars. Yet, after a careful investigation, I cannot succeed in tracing any cycle of returning warm and cold seasons. Three or four warm summers are generally followed by a variable number of cold ones. Previously to the great heat of 1818, there was for nine years a succession of remarkably cool summers. These Tables appear to destroy the expectation of any definite cycle of returning seasons being established, on which any practical reliance can be placed. It is, however, an important admonitory fact, that an unfavourable summer seldom appears alone.

81. It is further observable that the character of the spring is *generally* extended to the summer, a cold spring being followed by a cold summer. There are, however, many exceptions to this rule, but a late precarious harvest may be anticipated, if the early months of the vegetative season are cold and ungenial, and the husbandman will do well to prepare to make every exertion to ward off the effects of such a calamity. I proceed to ascertain—

82. *The amount of Heat necessary for the perfection of Wheat, in these Islands.*—Under this head I shall not follow the intricate course adopted by Boussingault, of determining the amount of atmospheric and solar heat requisite from the first growth of the plant in spring to the perfection of the grain.* This elaborate

* Journal of Royal Agricultural Society.

method may be the most definite, but it appears to give very dubious results, and would be of little practical utility to the British farmer. I shall therefore continue the same line of inquiry which I have thus far marked out, and which admits of easy reference to the indications of the thermometer, and to the tables of temperature which accompany this essay, by examining the *summer temperature* requisite for the production of wheat and the modifying effects of cloud and moisture.

The wheat-plant is distributed over a wide range of climate, from the hot, fertile valley of the Nile to the glens of Norway; it will therefore bear, or rather requires a higher temperature than is usually found in the British Isles. This limits our inquiry to the minimum amount of heat necessary for the ripening process under these cloudy skies.

The geological survey of Sir Henry De la Beche, and the numerous railway sections taken through the west of England form a good basis as to altitude; and from a long acquaintance with the state of the crops in this part of England I have ascertained that wheat in general fails to come to that perfection which justifies cultivation, at a height of 600 feet above the sea; allowing for elevation, this leaves a summer temperature of 58°. In confirmation of this position it is found that a deficiency of 2° of summer heat is followed by a great deficiency of crop in the lower lands, where the average temperature of this season is 60°.

On the eastern plain of England there are few hills to which the scale laid down (16) can be applied. But when the summer temperature has fallen to 58° the crop has invariably been most defective; in the year 1812 it fell to 57°·2, and the nation was on the verge of famine.

The hills and lowlands of Scotland afford for *that district* a much better criterion. At Hopetoun House, in West Lothian, where wheat has been most successfully cultivated, the average summer heat of 26 years is somewhat below 58°. The crop has been pushed so far to the North of Scotland,* that the mean heat of the season is only 56°. But then it is only in warm, sheltered vales where the harvest can be relied on.

83. *Thus in Scotland the minimum summer temperature required is from 56½° to 57°. On the south of England, where the summer days are shorter, and other things being equal, the amount of solar heat in the same time is less, 58° are requisite.*

It has appeared to me that the extra humidity of the western coast, and the greater amount of cloud supposed to exist there, requires to be compensated by an amount of atmospheric heat somewhat higher than on the eastern coast, but I do not find

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* Journal of Highland Agricultural Society, No. 14, p. 471.

that the legitimate inferences from the tables will justify this conclusion.

84. It is desirable that the agriculturist should know the temperature of the air on his estate, especially the summer heat, that he may have a correct estimate of its corn-ripening qualities. This may be approximately found by referring to Table No. 1, and by taking the temperature of the nearest place therein given, applying the correction for difference of altitude (16). The thermometer is, however, the best method of obtaining accurate results. The observations continued through one year will in general be sufficient, as the nearest station where the observations have been recorded for many years, will furnish the corrections of excess or defect to obtain the mean of a series of years. This temperature taken in connexion with local peculiarities, and compared with the minimum summer heat which wheat requires, will show the capabilities of the climate in respect to this grain.

85. The other cultivated grains, barley, oats, and rye, resist the cold much better than wheat, and are the only cereals which can be grown in high latitudes or on elevated districts.

The finer sorts of malting barley are a delicate plant, requiring a warm, moist climate and a friable soil. The low lands of the coast with an open soil, and a summer temperature not in excess, afford the climate best adapted. A dry spring is severely felt, especially if the land has not been worked between the wet and dry to a good state of tilth; but a moist, mild spring, followed by a good season at July and at harvest, is peculiarly favourable. Most abundant crops of superior barley are then produced in the eastern counties, on the barley-soils in the south and west of England, in Hereford, &c. The superior kinds of barley require a summer temperature little inferior to wheat, but coarse sorts will grow and ripen at the upper limit of ordinary cultivation in these islands.

The Scotch bere will endure a severe climate, and grows in Aberdeenshire at 1000 feet above the sea, where the summer temperature is 53°. The farmers of the Orkney Isles aver that white oats and barley do not suit the climate, but most abundant crops of black oats and bere are grown, the summer temperature being $54\frac{1}{4}$°. In Johnston's Physical Atlas barley is said to ripen on the Continent in a summer temperature of 46°·4; but this is not probable: it does not ripen in Iceland with a summer temperature of $49\frac{1}{2}$°, and at its northern limit in Norway at Kafiord, in latitude 70°, the mean heat of the summer months is 53°·4.*

86. *Oats* will not bear heat, and prefer a cold, late climate. A summer temperature of from 54° to 59° includes the degree of

* Dove's Tables of Temperature.

heat best adapted to the oat. Where it exceeds 59° barley should be grown in preference, if the soil is favourable. Thus in North Wales, in the north of England, and in Scotland this grain is grown in great perfection. In the moist climate of Ireland ten acres of oats are grown to one of other corn. Excellent crops are grown at Exmoor 1000 feet above the sea, yielding 60 bushels an acre. On Dartmoor, 1100 feet high, this grain answers well, the harvest being about a fortnight later than on the low lands.

87. The mild, wet winters of the west often produce injurious effects on the wheat crop. The plant is kept in a state of excitement during a mild February and March, and puts forth its powers of growth only to be cut down by a frost, or to be injured by a north-west wind. A continuation of warm, moist weather through the spring, produces a great bulk of long flaggy straw, which is laid by the westerly gales or by a few showers of rain. A cold March is therefore especially desirable in the west, and generally arises from the continuance of easterly winds, driving back the moisture of the Atlantic, and covering the land with the dry air of the Continent. The growth of the wheat-plant receives a wholesome check, which causes it to spread (tiller) better, prevents a premature development of shoots, and promotes on the return of spring that healthy vegetation which is so essential for a productive harvest. A dry March is also desirable for the spring crops, in order that the ground may be well cleaned and properly worked. It has become a proverb in the west, that "a peck of dust in March is worth a king's ransom." The most productive harvest ever known in this part of the kingdom (the south-west) was in 1818, when February was 3° below the mean, and the whole of the spring months below an average. The summer was in excess 4°·3.

88. The wet winters in the west of England further injure the wheat on undrained clay soils by an excess of moisture. If sown in ridges, the middle of the ridge has the best chance to escape the damage, and some little of the top-water is thrown into the furrow and runs off; but the interstices of the soil are so choked with water, that no air can get to the roots of the plants, which sicken and turn yellow. The heavy winter rain also beats the surface of the soil into a paste, which on the return of dry weather is baked into a hard crust, hermetically sealing the land to atmospheric influence, and so injuring the wheat that a scanty crop invariably follows. The best husbandmen are therefore desirous of not working the wheat-land down to a fine tilth, but to leave it in a rough state; the clods are broken by a roller in spring, and a light harrow opens the soil; the wheat wonderfully revives and flourishes after this treatment. It should be remembered that thus lightly breaking the face of the soil, has a beneficial influence

to a much greater depth than the harrow penetrates, by the access thus given to atmospheric agency.

89. During winter, and in the spring months, heavy gales from the west and north-west frequently occur; and the surf from the Atlantic rolls with tremendous force on the iron-bound western coast. When the wind has been blowing half a hurricane I have watched the effect of the breakers from the top of the cliffs; the frothy spray of the waves was whirled about the base of the rocks, until caught by the baffled wind it was carried upward with amazing velocity high above the land, and is thus scattered over the country to a considerable distance from the shore. I have seen many acres of wheat thus completely destroyed by this "breach of the sea," as it is termed. The saline particles in the air may be tasted on the lips; the tender buds of trees and grass, as well as corn, are blighted and wither under its influence.

On attempting to reach the coast in a late storm, the force of the wind was so great that I was twice thrown down; but on the edge of the cliff, though fully exposed, no wind was perceptible. I stood as if in a charmed scene; a hurricane was around me, but I felt it not. A moment's reflection showed me that the wind rushed up the face of the cliff with such force as to form a kind of bower above my head. By means of this upward current pieces of saline froth, 6 inches in diameter, were thrown high into the air, and reached a corresponding distance inland. A large quantity of salt is thus lodged in the soil.

90. When a south-west wind veers around to the north-west it generally blows heavily, and proves most injurious to the wheat-plant in February. When this wind is long continued, exposed fields rarely recover the effects produced; if a fine summer and well-filled ear follows, yet the crop of straw is thin.

91. The general strike of the geological formations of these islands is south-west and north-east, which is in the direction of the prevailing winds. The range of the mountain-chains do not, therefore, afford that shelter which, under different circumstances, they would give; and of which Herefordshire and Cheshire, protected on the south-west and north-west by the Welsh hills, are good examples. The surface of Ireland is greatly exposed from this cause, and being mostly destitute of timber, the south-west winds have a clear sweep over the island. The soil on the limestone being thin and friable, the little wheat grown is subject to be blown out of the ground. The most sheltered district is that on the north-east; where the soils on the grauwacke and trap being more loamy and deeper, the wheat-crop succeeds better, and is more generally cultivated.

92. In the south-west of England there is a marked difference (indicated by the state of the timber) between the shelter in the

secondary valleys which open to the west, and those on the eastern side of the water-shed line.

Most of the ancient mansions have an east or south-east aspect; and with elevated ground behind, ornamental plantations and timber may be raised around the house with perfect success. But the west or north-west is the most undesirable aspect possible for land, or a residence; the wind from that quarter clips the hedges, as if by a gardener's shears, on the west coast, from Cornwall to the north of Scotland; so that the points of the compass may infallibly be known by the state of the fences. This wind loses its peculiar character further east, and the beauty of the landscape is unscathed by its influence. The noble timber found in the midland counties, even on elevated ground, throw out their boughs uninjured in all directions. There can, however, be no question but that the hills of Wales, Cumberland, and Scotland afford valuable shelter to some of the eastern lands.

93. The low eastern coast is fully exposed to a cold blighting wind from the north-east in spring, generally in April or May, but sometimes continued till June. The hills of Scandinavia are covered with snow till the middle of May, and the temperature of the air is down to at least 32°; the mean of that month in England is about 54°: this rarefied air will ascend, and be replaced by a cold current of dense air from the north-east. For the same reason this wind will be stronger by day than by night: hence the sailor's phrase, "an easterly wind, up in the morning and down at night." There is a peculiar character of regularity about this wind. In the morning it gradually rises into a stiff steady breeze, and then as gradually dies away. The south-west wind, on the contrary, blows at all periods, but more especially at night, when its sudden squalls, and fitful gusty moanings, seem like the agony of an unquiet spirit. This character, which is impressed on it along the region of the Gulf-stream, is so dreaded by sailors that they now forego the benefit of the drift of the current, in order to avoid the squalls which accompany it.

The north-east wind is felt severely in Scotland in April and May, keeping back vegetation in spring, and shortening the cool summer. In Norfolk it is injurious to the fine stock, as well as the crops; and in Kent its blighting influence is further extended to the fruit-blossom, which is often cut off.

In addition to the low temperature of this wind, its dry exhaling character causes considerable damage. The mild winters of England often force the grass and wheat forward in spring, and in calm weather a humid atmosphere, from ordinary evaporation, hangs around the herbage, which is very conducive to vegetable growth. The cold wind from the east sweeps this away, and supplies its place with a continuous current of dry air, which exhales

all the moisture from the leaves, and rapidly dries and withers the plant.

94. The climate of Scotland, in an agricultural point of view, has many great defects, among the chief of which may be reckoned —the low summer temperature—the lateness of the spring—the occasional prevalence of north-easterly winds, and fogs—with the heavy shake-winds from the mountains in September. Much rain often falls in the latter part of the summer, causing great damage to the crops, and a cold wet harvest. In the low land of Dumfriesshire, on an average of ten years, upwards of 4 inches of rain falls in July. These circumstances call for all that skill, activity, and foresight which characterise the Scotch farmers.

95. *Effect of Climate on the Growth of Roots, Grass, and Fodder.*—I have placed this under a distinct head, as a climate in many respects different from that required for grain is the most desirable. Whilst the dry atmosphere and generally heavy soils of the eastern plain of England are well adapted for the perfection of wheat, the cool summers and humid air of the western coast, and of Scotland are better fitted for the production of roots and fodder. The structure of the soil is also open and porous, and, except on some few clayey districts, the large quantity of rain is readily absorbed. Ireland has the most humid climate, but it has also the most friable soil. If the clay of the lias, or of the Weald of Kent, were largely developed in Ireland, it would present a scene of cold sterility. But its light warm soil, and moist air, are peculiarly fitted for the production of the potato, which has yielded abundant crops under the most wretched system of culture. This root everywhere delights in a free open soil, with plenty of moisture; and, under nearly similar conditions of climate, has been also extensively cultivated in Lancashire, Cornwall, and in the south-west of Scotland.

96. The *Turnip* is sensitive of climate and soil, and though its great agricultural value will more than justify its being raised in situations not the best suited, yet under more favourable conditions, heavier crops will be grown. On a close clayey soil saturated with rain, turnips will not grow; and on a light sandy soil, without moisture, they cannot. A soil open to atmospheric influence, supplied with a considerable quantity of moisture, and having a good under-drainage, in which manure can be rapidly decomposed, and fitted for assimilation, is that in which they delight. The plant grows fast and will not bear a check, so that a constant supply of air, moisture, and nutriment to the root is indispensable. A cool summer, and mild genial autumn, are further desirable to bring the bulb to its greatest perfection. These requisites are more generally found in the west and north of England, and in the low lands of Scotland, than elsewhere in Bri-

tain; and it is in these districts that the culture of the turnip is the most successful. The Orkney islands have of late, under improved culture, grown excellent crops of turnips, and the distribution of temperature at Sandwick, given in Table No. 1, shows the conditions of heat highly favourable to this root.

97. On the warm south-east plain of England the turnip does not succeed so well as further north, though this crop constitutes the main-spring of the improved husbandry of the eastern counties. The great heat of summer will not admit of so early a tillage, and cold winters still further limit the period of growth. But the success of the turnip-crop more especially depends on the proper supply of moisture in June, July, and August. It is highly creditable to the agriculturists of the south-eastern district, that with an annual amount of rain, about half that of their more favoured neighbours of the north, such excellent crops are raised. During the summer months, indeed, this district has a larger proportion of its own smaller annual amount than falls on the western lands. But it appears that the country around Chiswick, for instance, is subject to considerable variations in different years; occasionally not an inch of rain falls a month, and the average for each of these months, for ten years, is $2\frac{1}{4}$ inches. At Manchester the average rises to $3\frac{1}{4}$ inches; at Applegarth manse, Dumfriesshire, to $3\frac{2}{3}$; and at Orkney the quantity is $2\frac{1}{2}$ inches. Thus the advantages of climate and moisture are greatly in favour of the northern and western counties.

98. In the south-west of England turnips have been cultivated with great success. The parish of Probus, Cornwall, is one of the best farmed parishes in the county; and the structure of the soil, and the amount of rain, are highly favourable to this crop. The rock is a decomposable clay slate, *nearly on its edge*, which affords an excellent under drainage, on which lies a clayey but porous subsoil, and on this a deep, healthy, friable loam. About 3 inches of rain fall per month during the most rapid period of the growth of the turnip, and the nature of the soil is such as admirably to regulate the supply of moisture to the root. The plant seldom receives a check from drought, and consequently is not subject to mildew, and heavy crops are yearly raised.

In some parts of the slate-formation the beds lie horizontal, and a thin soil rests on a subsoil of clay. In such districts the turnip is a most precarious crop, and seldom does well. The soil is either saturated with water, or very dry, and a few weeks of hot weather bring on the mildew in its worst form.

On the elevated land of Dartmoor, with a granitic soil 1100 feet above the sea, under the excellent management of Mr. Fowler, turnips answer remarkably well. He writes me under date of the 27th of October, 1849:—" My stone turnips, with tops and

bottoms off, are per acre, 29 tons 1 cwt. 1 qr. 9 lbs.; and swedes, in the same state, 34 tons 11 cwt. 1 qr. 20 lbs. The latter weighed this day by the South Devon inspector. This climate suits roots and grass, but I am not certain as to grain, except oats, which, with early cultivation, do well. The harvest is about two weeks later here than on the low districts in this county. I began oat cutting in 1848 on the 29th of August, and this year on the 31st of August. Vetches and rape flourish well."

99. Turning our attention to Ireland, we find that the north part of the island is formed by a continuation of the geological formations of the lowlands of Scotland and of the north of England. The structure and constitution of the soil is therefore generally the same in these districts, and the climate is of a similar character, except that the air is more humid, and the winters milder in Ireland. The success of the turnip husbandry on the limestone of Northumberland, and on the grauwacke and trap of Scotland, is a demonstration that similar success would follow the same course of culture in Ulster. Mr. Blacker has done much to extend the cultivation of the turnip in Armagh, and with an improved rotation the most beneficial results have followed.

In most parts of Ireland the land is tilled for many years with potatoes, followed by a succession of oat crops till it is exhausted, and is then left down "to rest," as it is termed, in a miserable state of foulness. Clover and artificial grasses are little known, except in the most advanced districts. On this wretched system the cattle are half-starved, and in that state a large number are sent yearly to the English markets. They are the most unprofitable beasts that can be purchased, for it requires much time and food to get them into a proper state for producing beef; and the animal is much subject to disease, if the seeds are not already sown. The "pleuro-pneumonia," which has proved so destructive to the best English stock, was introduced by some half-starved cattle from Ireland.

Under a good system of culture the soil of Ireland would produce large supplies of roots and green fodder; the number of store cattle might be greatly increased, and many fed at home. The surface is mainly covered with a soil derived from limestone, or from grauwacke mixed with trap, and considering its adaptation to the quantity of rain which falls, and that the temperature of the south part is higher than any other portion of the British Isles, and that the north is warmer than the productive lowlands of Scotland, it becomes evident that Ireland has agricultural capabilities, which, if properly developed under a good system, would render it one of the most prolific countries of the substantial necessaries of life in Europe.

100. The *Beet-root* (mangold-wurzel) requires a warmer climate and a richer loamy soil than the turnip. It therefore flourishes remarkably well in the south-west of England. An analysis of the ashes of the beet shows that it contains 29 per cent. of chloride of sodium, while the turnip gives only 8 per cent.* The saline particles lodged in the soil near the sea (89) must therefore be highly conducive to the growth of this root, and it is found in such situations to answer well. On the Barton of Tehidy, Cornwall, upwards of 30 tons per acre were raised last year, and this not above an average crop.

101. *Fodder plants* grow with great vigour in the humid climate of the west. Vetches on light land with a little guano produce a heavy crop. Italian rye-grass answers remarkably well, and winter-rye yields an enormous quantity of early fodder in the spring. But no plant has been introduced into the west with such marked success as rape: it scarcely ever fails, and forms a cheap and excellent preparation for wheat. Red clover begins to sicken, and a change is evidently desirable.

102. *Grass.*—The convertible system of husbandry is that generally pursued in the south-west and north-west of England; the land is in corn for two years, and then laid down to pasture for three. The rye-grass and clover the first year is usually heavy, but in the two succeeding years, the pasturage, except on good soils, is not worth the tithes and taxes. The clover fails, the rye-grass runs to a hard stem, and the natural grasses have not time to gather strength to produce their sweet herbage.

The greater part of Ireland is admirably fitted by its climate for a grazing country. On the natural pastures the verdure of the turf continues all the year, even on the thinnest limestone soil, and hay is generally the product of the natural grasses. The mountains also furnish much superior pasture to the Welsh or Scotch hills. And yet little good grass on the up and down land is raised, in consequence of the wretched system, and worse culture.

There is nothing so desirable in the present state of the grass land in the western counties and Ireland, as to militate against the introduction of a better system of culture. On the contrary, the generally wretched state of the grass land in a climate calculated to produce an abundance of fodder, demands a rotation which would remedy the evil, and prevent the loss now sustained.

The rich grazing districts of Gloucester, Cheshire, and Northampton are covered with a rich herbage greatly superior to that which has been reviewed. The greater amount of heat and light impart a deep green, and give a compactness of structure to the

* Royal Agricultural Society's Journal, vol. viii. p. 199.

grass, which renders it more nutritious than the first year's seeds rapidly grown in the moist climate of the west.

103. *Effect of climate on table vegetables and fruit.*—Market-gardens are usually situated near the population which create the demand. But railways now offer such a rapid mode of transit that the capabilities of distant districts, more favoured by nature, have been drawn on. A mild winter with an early spring, a light, warm soil, and shelter from injurious winds, are the conditions of climate most favourable. Several such spots may be found on the south coasts of England and Ireland. Mount's Bay will afford a good illustration of the value of local climate. The decomposed hornblende rocks around Penzance, form a rich warm soil, sheltered by a range of granite hills on the west and north. The January temperature is 42°. From this neighbourhood large quantities of vegetable produce have for some years past been sent, viâ Bristol, to the London market. Broccoli are ready for the table at Christmas; cabbages as early as February; turnips before the end of March; and green-peas by the middle of May. But it is for the production of the early kidney potato that this mild climate is most remarkable. The "*rare crop*" is planted in November, and manured with sea-weed, the plants appear in the second week in February, and the first batch of potatoes is usually sent to Covent-garden market about the 1st of May; a succession is continued through June and July. When the first crop is drawn a second crop is immediately planted, even so late as July, and yields a good return. About 250 acres of early potatoes are grown yearly around Penzance.

104. But the mild winter of the west is very unfavourable to fruit-trees. The spring often appears to set in prematurely; so that the trees are pushed into bud, and blossom appears only to be destroyed; and when the tardy summer comes, the heat is generally insufficient to impart that rich flavour to the fruit which constitutes its perfection. The grape rarely ripens in the open air; the apricot seldom affords any fruit, and the greengage plum is equally unproductive. Filbert-trees, which succeed so well in Kent, cease to yield any nuts; and white currants contain much acidity. But strawberries are abundant and superior, and gooseberries come to great perfection. In Ireland, also, it is a common topic with gardeners that the mayduke has lost its flavour, and that peaches do not ripen well.

105. *The apple* requires shelter. It will not stand the scouring effect of the south-west, or the blighting influence of the north-east wind, and therefore seeks a locality removed from either coast. In the close, warm vales of South Devon the trees are productive, and much cider is made (the South Ham). But the most favoured situation for the perfection of this fruit, is in the

counties sheltered by the Welsh mountains, where the soil is rich, the surface undulating, and the summer warm, and where the destroying east wind has less effect than in any other part of England. For these reasons the counties of Hereford, Gloucester, and Worcester are celebrated for their orchards, and make large quantities of cider and perry. Shelter from blighting winds, a situation above the cold fogs of the valley and the reach of hoar-frost, are the requisites of climate which should be sought.

106. *Effect of Elevation on Agricultural Produce.*—The effect of elevation on temperature has been already examined (16), and the result of careful observations gives a decrease of 1° of heat for every 270 feet of altitude. Lands at an ordinary level have not a greater summer heat than is desirable for grain-crops, and this rapid diminution of temperature limits the superior kinds of corn to a lower elevation than is generally supposed. There is also great irregularity in the ripening of corn on high lands. The state of the soil and local climate produce different effects at the same height. Some late soils in the west have had an earlier harvest by a week or ten days, by a liberal application of shell-sand from the coast. In dry warm years the difference is but small between the time of harvest on elevated and low lands; but in wet years, on the high moors of the north of England and Scotland, this time is extended to six weeks, or even two months. From this cause very contradictory statements and opinions are afloat on this subject. In consequence of the drier air of the east and middle of England, the cultivation of corn can be carried successfully to a greater height there, than on the wet western coast.

In the west of England, wheat is grown with variable and often doubtful success to a height of 600 feet. Oats answer well at 1000 feet, the harvest being from ten days to a fortnight later than on the low lands.

In Wales, on the sides of Cader Idris, bad crops of wheat are grown at 700 feet. On the great English plain there are few, if any, places where the climate prohibits the growth of corn. On the wolds of Lincoln and York, excellent barley is grown. The general height of the Cotswold Hills, omitting the highest points, is from 500 to 600 feet; and it is doubtful whether wheat can be grown with that advantage which justifies the exclusion of another crop. The middle part of the Yorkshire moors is about 1000 feet high, oats and bere are the principal crops; wheat is seldom sown higher than 800 feet, and is then precarious. The harvest on the moors is a month later than on the low lands.

With respect to Scotland, I have been favoured on this subject with a letter from the Rev. William Dunbar, whose meteorological observations are well known. It contains such valuable

information that I prefer giving it in his own words. It is dated Applegarth Manse, February 14, 1850:—

"I have to acknowledge the receipt of your letter of the 9th inst., and desirous of furnishing you with the information you request as accurately as possible—more so than I could of my own personal knowledge—I applied to a friend in this neighbourhood, Mr. Charles Stewart, who of all others in the south of Scotland is the highest authority on the subject of your inquiries; and the following is the result:—

"'This district of country is a valley watered by several rivers, the largest of which is called the Annan, hence the said district is called Annandale extending from the source of the river to the sea, about 30 miles, in a direction nearly north and south. Along this valley, to a height of not more than 300 feet above sea-level, it has been the practice to grow less or more wheat; and in dry warm summers it ripens well, and is of a fair average quality—that is from 60 to 64 lbs. weight per imperial bushel; but from the humidity of our months of July and August, it is a very uncertain crop, on the average quite inferior, in point both of quality and quantity of produce, to that of the counties along the eastern coast of Scotland from Berwick to Caithness, where, on the whole, the average temperature of the summer months will not be higher than ours, indeed a little lower. In these eastern counties, wheat is grown in suitable soils as a regular paying crop; but I think this suitableness scarcely extends to more than 300 feet above sea-level.

"'In this county of Dumfries little wheat was grown before the year 1800. From that to 1815 it rapidly extended, and might be equal to about one-sixth of the extent of the oats in the lower valleys and along the sea-coast. Since then it has gradually declined in extent, and now, I should suppose, it is not equal to one-thirtieth part of the oat-crops. As to the ripening of oats, I may mention that at Leadhills, on the northern boundary of this county, land is cultivated by the lead-miners for the sake of potatoes and hay, and oats are occasionally tried; but rarely, perhaps not once in seven years, is there any meal or kernel in them—they are used merely as straw for cattle. Leadhills village is 1400 feet above sea-level. Potatoes, in most years, grow a crop perhaps equal to two-thirds of that in low grounds. I mean as to *quantity:* the *quality* is not good. I know, however, farms in Lanarkshire, the county adjoining to this on the north, about 1000 feet above sea-level, where oats are cultivated regularly in rotation with other crops; and the old Scotch barley, or bear, perhaps more successfully than the oats.

"'The extent of cultivation, however, either of grain or green crops, on soils more than 700 feet above sea-level, is in this county very small. Potatoes clearly grow at a greater altitude than turnips, and I should say at 300 or 400 feet higher than oats—that is, with no larger diminution of growth, below an average of the proper altitude for both. I need not say, however, that the soil or nature of the subsoil has much to do with the ripening in all cases of grain or green crops.'

"Such is the information furnished me by my skilful friend Mr. Stewart, and in his own words. You may rely on its accuracy, and I hope it will prove satisfactory."

This communication has an additional value from the fact that the summer temperature of Applegarth Manse is 57°, being near the minimum which I had before determined as requisite for the growth of wheat. The decline of the crop in this district is thus confirmatory of the view advanced on this subject (83).

The returns to the Highland Society of competitors for the best seed-corn, show that in 1848 all the samples were grown below 250 feet. In the previous year, the greatest altitude given is only 40 feet above the sea, so conscious are the growers of the effect of elevation on the quality of the grain in Scotland.

107. *The Situations in Great Britain and Ireland proved by experience to be best suited for each kind of Agricultural Produce and Stock.*—The inquiry under this head has been to a large extent necessarily anticipated in the former parts of this essay. I shall now confine myself to an epitome of the leading facts, drawing only a strong outline of the picture, and leaving the details of light and shade to be supplied by individual experience in the districts named. The nature of the soil will of course form an element which in practice cannot be excluded in the adaptation of plants to different localities. My remarks will therefore only apply to such soils as are favourable to the different crops.

108. *Wheat* has been naturalized, in a climate congenial to its requirements, in the great eastern plain of England. From the Welsh mountains to the North Sea, and from the Isle of Wight to Durham, the principal wheat-producing district of these islands is found. Some light soils are more favourable to barley, and others, from the expense of working, remain in permanent pasture; but this portion of the kingdom hitherto has furnished the chief supply, and must maintain its pre-eminent adaptation above all others for the production of this grain. In some parts, wheat is grown every alternate year, with beans or a green crop. The extension of such a system, if the soil would bear it, in this favoured district would be of great national importance. There is land enough in a moist and mild climate for barley, and in cold districts for oats. The dry air and greater heat and light of the middle of England give a peculiar colour and firmness to the straw which is not met with elsewhere; of which the Dunstable straw for making bonnets affords a familiar example.

Another valuable wheat-growing district, though with much inferior capabilities, is found in the eastern counties of Scotland as far north as Aberdeenshire, where it ceases, except in a few sheltered spots; for wheat will not succeed in a light granite soil in a boisterous climate. The Merse of Berwick, Teviotdale, and the rich alluvial lands or "*carses*" on the banks of the Forth and Tay, have superior qualifications of soil and climate.

Cumberland, Lancashire, and the western lands generally, are very defective in corn-ripening properties; and this influence is felt by wheat more severely than other grains.

Ireland generally has neither soil nor climate well suited to wheat. The land on the limestone is too thin and hot; but there are some strong loams on the north and the south, and some superior low land

around Limerick, on which wheat is grown successfully; but it is said to be inferior in quality, not yielding so much saccharine matter by from 10 to 15 per cent. as average English wheat. But—

109. *Barley* may be grown in Ireland with great advantage; its climate on the south and east appears particularly adapted to this grain, and where it has been properly cultivated the yield has been large; some districts in Wexford have been long noted for their great crops of barley.

The eastern counties of England, from their light warm soils enriched with chalk-marl, and their superior climate, must continue to raise the best samples of malting-barley; but where the slate is mixed with trap, and especially where the soil on the honeycomb-dun is found in the west, I have seen most abundant crops, which cannot be excelled. The sheltered position, warm mild climate, and the fragmentary nature of the soil in parts of Hereford, renders it a locality highly favourable to barley, and large crops are grown. The new red sandstone soil in Warwick, Leicester, and Nottingham is prolific of barley. In fact in England the distribution of the culture of this grain is governed by the soil rather than the climate.

Bere is confined to the north, but it might probably be introduced to the high late lands of the south and west with advantage.

110. *Oats* are grown *best* on districts too cold and moist for other grain; the border parts of England, Scotland, and Ireland, have long raised large quantities. In Ireland the oat has had almost universal dominion. Sir Charles Coote says, that in Cavan the oats were to other grain in the proportion of *seventy* to *one*. And throughout the whole island at the present time *ten* acres of oats are raised for *one* of other corn.

The superior cereals have in Scotland excluded the cultivation of the oat, as far *as the climate will permit*; but in Ireland, especially in the warm mellow climate of the southern parts, this inferior grain is still largely cultivated, where wheat and barley might be grown to great advantage.

The following distribution of the amount of grain raised in the British Isles is extracted from M'Culloch:—

	Quarters of			
	Wheat.	Barley.	Oats.	
England and Wales .	12,350,000	3,600,000	13,500,000	Oats including Beans in England.
Scotland	660,000	980,000	5,757,500	
Ireland	Not est	imated.	16,000,000	
	13,010,000	4,580,000	35,257,500	

Gardens and Orchards—see paragraphs 103, 104, 105.

111. *Stock.*—If the cattle of this country were kept in a state of nature, it would be of the utmost importance that the breed should be adapted to the climate. But by the introduction of artificial food and shelter, larger and superior beasts may now be grown more advantageously than cattle which have become acclimated to a particular district. This, however, forms no part of the present inquiry, further than to remark that the extension of root and fodder crops should be followed by beasts fitted for house-feeding, having the valuable properties of early maturity and facility of fattening.

In a state of natural pasturage cattle show great sensibility to climate. In low alluvial plains, or vales where food abounds, the ox reaches his greatest bulk, with fine hair and a soft skin. But on the high cold uplands, with scanty food and exposure, he becomes very diminutive, with a thick skin and a shaggy coat. The range of the mountain-side, where food is scarce, gives an activity of limb, a restlessness of habit, and a wildness of character, unlike the sluggish mild beast of the plain.

The air being more rarefied on elevated regions, a larger amount must be drawn into the lungs to supply the requisite quantity of oxygen, and the respiratory organs are more largely developed: this is shown in the wide deep chest of the Highland cattle.

112. The effect of the climate and food of mountain regions on sheep is equally marked. On the low rich lands of the eastern coast of England, the original native breed is large and coarse; such are the old Lincoln, the Teeswater, the Romney Marsh, and such the Bampton sheep on the south-west; but in proportion as the land becomes elevated, the bulk of the animal declines, and the ratio of decrease very nearly agrees with the altitude of their pasture-lands. Thus we may trace the progression from the large sheep of the plains through the Cotswold, the Southdown, and the Cheviot, to the small sheep of the Welsh and Wicklow mountains. The old Bampton Nott at two years old weighs from 30 to 35 lbs. the quarter, whilst the highest mountain-sheep are only from 5 to 7 lbs.

Even the gradations of altitude on the hills are followed by corresponding effects on the animal. Our best authority on this subject, in respect to the breed on the Wicklow mountains, says—"The quality of the wool, as well as the general character of the sheep, varies with the elevation. In the lower rocky hills, as those which do not exceed 800 feet above the level of the sea, the wool is more fine and less mixed with hairs. At a higher elevation, where heath and wet bogs begin, the sheep becomes smaller and wilder. In these a ridge of bristly hairs extends like a mane along the neck and spine, and hair is always

found in quantity on the hips and dewlaps, as in the wilder sheep of Wales. There is here that adaptation which is everywhere observed in this species of animals, to the physical conditions of the country in which they are naturalised. The ridge of hair along the spine, and on the haunches and breast, causes the moisture to fall off, and is a provision against the wetness of the boggy soil."*

From these facts it is obvious that as we have in these islands great variations in the climate of different districts, the law of nature which governs the distribution of our stock cannot be departed from with impunity.

The animals of the vales have been brought to a high state of perfection in the improved short-horn, and in the new Leicester sheep. The mountain breeds should now receive equal attention, especially as they constitute a source of supply for grazing the rich lowland pastures. This cannot be done by crosses with lowland cattle, as it would destroy that hardihood of constitution, and adaptation to climate, which the mountain races now possess. The breeds must be kept distinct, and improved independent of foreign blood. In some instances it would be desirable to introduce another race, having the requisite qualifications for the climate. The thick-hided wire-haired beasts should be abandoned, for those which have a finer skin covered with a warm shaggy hair, one of the best qualities of a mountain breed, and which is well developed in the Pembroke, and West Highland cattle.

The sheep of the Cheviot hills have hardy constitutions and quiet habits; on the Scotch hills they have been introduced with great success, and as a mountain breed are in high estimation. The sheep of Wales, and of the Kerry and Wicklow mountains, might at least in part be replaced by this improved breed with great advantage.

113. *How far it is desirable to adopt the regular four-course arable system on the western sides of England and Ireland, the same being naturally fitted for the spontaneous growth of grass.*— The old system of cropping in the south-west of England was to take two corn crops in succession, and to lay the land in grass for three years. There was little feeding, the cattle being driven to the rich eastern pastures. Of late a turnip crop has been introduced to some extent between the white crops, and the more advanced farmers grow rape and eat off with sheep as a preparation for wheat: still the "three years out" is considered indispensable.

In Lancashire, after two crops of corn and green crops, the land is kept in seeds and grass two or three years; and in

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* Low on the Domesticated Animals, ed. 1845, p. 73.

Ireland, after an exhausting course of potatoes and oats, it is left out "to rest" for several years.

One of the worst points of this system is the wretched pasturage (102) on land well adapted from its nature and humid climate to produce large quantities of fodder. Turnip culture forms no part of the original system, but the value of the crop has led to its occasional introduction according to the taste of the cultivator. Intelligent farmers have done much to remedy the evil, yet still the rotation is in a transition state. Few except those blinded by prejudice are satisfied with the old state of things; but many have not the means, nor others the inclination, to attempt an improvement. The door of inquiry is open, and both landlord and tenant will examine the question with much interest.

Though the climate of the south-west of England is naturally fitted for the spontaneous growth of grass, it is still better adapted to the growth of roots and fodder plants, which the introduction of the four-course shift would promote.

Most of the land is strictly arable, the soils being healthy and open, and may be "got on" at any time of the year (excepting a small portion of lias clay, and a clay district in North Devon related to the coal-measures). The improved plough, drawn by two horses, has been in use for some years, and the land is easily worked. Such land will never be laid down to permanent pasture, and the present alternate system produces so small an amount of grass, that an improved rotation adapted to the climate and soil is greatly required.

With these advantages it must, however be admitted, that the climate of the west is not favourable to an extension of the wheat crop, though on some low loamy soils it may be grown with profit oftener than it is; yet on the great mass of the arable land it shows such a tendency to run to straw, and to lodge before the westerly wind and rain, and the weather at harvest is so precarious and often wet, that the judicious growth of this grain will be limited by these circumstances.

The cause of this tendency to lodge has often been considered at the Probus Farmers' Club, and it has usually been attributed to a deficiency of inorganic food to strengthen the stalk. There can be little doubt that with a rapid growth of straw, the silicate of potash is not proportionately supplied, the outer glazed coating of the reed is therefore thin; the stalk is weak and ill defended from the attacks of disease and insects; it is thus predisposed to lodge before boisterous weather, and mildew often follows. Old ley-fields produce the stiffest reed and the fullest ear; but where the wheat crop is often repeated the grain becomes very inferior. Silica forms from 60 to 90 per cent. of these soils, but the process

by which it is fitted for assimilation is slow (perhaps through the deficiency of the alkali), and the general experience of the farmers is against the growing of wheat on a grauwacke soil oftener than once in five years.

On inspecting the valuable analyses of the ashes of wheat in the 7th Volume of this Society's Journal, I observed the instructive fact, that the perfection of the grain is dependent on the quantity of potash it contains. I have extracted the following examples of Hopeton wheat as illustrations:—

Lbs. per Bushel.	Description.	Potash per Cent.
56	Bad	26·9
59	Grain good . .	33·15
60	Thin	30·32
61½	Rather thin . .	32·05
62	Good	34·51
63	Good	36·43

These facts show, that wheat cannot successfully be grown unless the soil contains an adequate supply of potash, and where this crop occurs oftener in the rotation than the alkali in the soil will bear, the grain must ultimately prove defective in quality.

On the north of Cornwall, at Lambourne, on a grauwacke soil, the four-course shift was strictly adhered to, but the quality of the wheat fell off so much, as to induce some modification of the system. Wheat is, however, grown in quick succession, on a low lying loamy soil near Wadebridge.

Red clover has not answered well in the West of late; but rape has been so advantageously raised, and forms such an excellent preparation for wheat, that it must form a part of any efficient rotation adapted to the soil and climate. For these reasons I am of opinion that the general introduction of the four-course system would not be successful in the West. On low-lying rich loams, here and there, it would no doubt succeed; but a rotation which combines the roots and fodder of the four-course, with such an alternation of grain crops in which wheat forms a less prominent part, and then preceded by rape, is that which, under the general circumstances of soil and climate, is best adapted to the district.

114. A rotation founded on these principles has been for many years carried out on a light grauwacke soil, by Mr. Henry Gatley, an excellent agriculturist near Truro, and with the most satisfactory results. As it is well calculated to raise the amount of produce in the West, I shall give it in detail.

1. *Grass-seeds.*—Cut to hay or soiled, the after-grass depastured. About the first week in February the land is ploughed, and as soon as the weather will permit, sown with
2. *Black Oats.*—2½ cwt. of guano is sown per acre, and the average produce is 40 bushels. After harvest the land is ploughed and lies fallow through the winter. About the first week in April, if in condition, half is sown with rape and mustard mixed; the other half is sown with rape at different periods for a succession, thus forming the next course of
3. *Rape and Mustard.*—The mustard comes to stock three weeks before the rape; the whole is manured with artificial manure, and eaten on the land with sheep. One ploughing with muck, and the whole is sown with
4. *Wheat.*—The Old Cornish White; the average produce 24 bushels per acre; 62 lbs. per bushel. Immediately after harvest the land is ploughed; half lies fallow for early turnips, half is sown with winter vetches, which is a stolen crop eaten off with sheep; the whole is tilled with
5. *Turnips.*—Manured with bone and phosphate, and drilled with field-ashes, kept dry through the winter. The crop is folded with sheep, and the whole goes to
6. *Barley.*—Red clover and Italian rye-grass are sown, which begins the course again.

About 120 acres of light land are kept in this rotation: near the homestead some better land is worked on the alternate system; after wheat, turnips, and barley, it is laid down to pasture for some years, and receives a liberal grain-dressing from the dung arising from the green crops.

The ease with which these crops follow in succession, with the little working which the soil requires, after being once cleaned, is an excellent point in this rotation; to use Mr. Gatley's own expression, "The system tills itself." It is generally admitted in the West that the barley crop is not so good after turnips as after wheat; this mainly arises from the fact that the turnip-land is poached, and is left unploughed until dry weather in spring so hardens the soil that it cannot be reduced to a proper tilth; Mr. Gatley has obviated this by early ploughing, and by the use of Crosskill's patent clod-crusher.

This rotation has all the benefit of the fodder and roots of the four-course, avoids the too frequent repetition of wheat, which it precedes by rape, and appears admirably adapted to raise the agriculture of the West.

The effects on Mr. Gatley's farm are as follow:—

	Old System.	Improved.
Store Ewes kept	70	120
Calves reared	8	20
Stock of cattle	50	80
Cattle fed per year . . .	12 or 15	50

It is only by the introduction of such a system as this, with minor variations to meet local climate or soil, that the agriculture

of the West can be effectually improved. The present wretched system of pasturage must be abandoned, and a well arranged succession of good fodder and root crops substituted; and to this course the climate is most admirably adapted.

115. There is no part of the kingdom where an improved rotation would bestow greater benefit than on Ireland: throughout this Essay it has been often stated how greatly the climate is fitted for roots and fodder: it is therefore satisfactory to find that the four-course has been tried with great success. Mr. Blacker has efficiently helped onward this great improvement in Armagh; and numerous public testimonies have been given to the advantages which follow. In an able pamphlet on the subject, Mr. Blacker says, "I have only to add that, in all cases, those who have adopted the improved system of cultivation have derived the benefit from it which might be expected; old prejudices are annually giving way, and the growth of turnips so much increasing, that I have no doubt, in a few years, they will be universally cultivated, not only in the county of Armagh, but in every part of Ireland."

Like the West of England, Ireland will require some modification of the four-course shift; but yet the great principle involved must still be kept in view—an alternate grain and green crop. If the productive power of the soil of Ireland was fully developed under this system, an amazing amount of roots and fodder would be raised, which would render that island the best beef-producing country in the world.*

116. The various heads of inquiry suggested for this Essay have now been discussed, though not in the same order in which they appeared, but I have made such an arrangement as would best comport with the materials I could command—laying the foundation in an extensive series of meteorological observations brought into a condensed form, and then endeavouring to apply the facts to agricultural operations and progress. Many of the topics are briefly and imperfectly treated, but the limits of an Essay would not permit extended remarks: I have therefore kept leading principles in view rather than minor details.

On prognostications of the weather I have not ventured, this subject having been copiously expatiated on by agricultural writers from the 1st Georgic of Virgil to 'The Book of the Farm' by Stephens, and with little practical benefit: I have therefore preferred filling a limited space with less dubious materials. A valuable pamphlet on this subject has just appeared from the pen of E. J. Lowe, Esq.,† which shows that but

* "It may be satisfactory to the Society to learn that Mr. Peter Falconer, to whom their medal was awarded, had 61 tons of Swedish turnips, and 69 tons of mangold-wurzel, to the acre."—*Rep. of Iverk Farming Society, Kilkenny.*

† Published by Longman.

little reliance can be placed on the usually received prognostications of rain.

117. I shall only add, that while there is no evidence that the climate of this country has deteriorated, there is every reason to believe that the winters in particular have been acquiring a more genial character; not by any great physical change, but by the extension of agricultural operations, improving the condition of the surface soil.

The severe winters so minutely described by Virgil, nearly 2000 years ago, as occurring on the Danube, after making every allowance for poetic language, are no longer applicable to the borders of that river.

> "With axes first they cleave the wine; and thence,
> By weight, the solid portions they dispense.
> From locks uncomb'd, and from the frozen beard,
> Long icicles depend, and crackling sounds are heard.
> Meantime perpetual sleet, and driving snow,
> Obscure the skies, and hang on herds below.
> The starving cattle perish in the stalls;
> Huge oxen stand inclosed in wintry walls
> Of snow congeal'd; whole herds are buried there
> Of mighty stags, and scarce their horns appear."
>
> GEORGIC III. (*Dryden's Trans.*)

The severe winters of the past century seem in a great measure to have disappeared from the present. From 1708-9, "*the cold winter*," to 1795, when in January the temperature was 12° below the mean, there occurred twenty winters of extreme cold in England. In these severe seasons large quantities of cattle died, the forest trees were split by the frost, and the Thames was several times frozen over. But in the first half of the present century, there has scarce been a winter which can be placed in the same category. Only in two years was there any approximation to this excessive character—in 1814, when the January temperature fell 8°·7 below the mean, and in 1838, when the deficiency was 6°·7. In 1708-9 the severe cold was followed by an east wind, and on the north-east side of the furrows over the whole kingdom the wheat was generally destroyed, and a great dearth followed; but in 1814, though the crop suffered by mildew, the supply was so good that the prices dropped from 109*s.* to 74*s.* and 65*s.* the quarter. The severity of the ancient winters therefore appears to be greatly modified.

There are grounds for expecting a further improvement in the climate of these isles. The skill and industry of man have a greater influence over the elements of climate than at first sight appears. Cold and noxious morasses, where hoar-frost was gendered, have been converted by draining into dry healthy land; wild and bare hills, where cattle could scarce stand the exposure, have by judicious planting been changed into fruitful corn-fields.

These, therefore, are the two sources from whence an improvement in the climate must be looked for—draining, and planting for shelter.

Heat is mainly communicated to the atmosphere by radiation from the soil, and where the pulsations of heat are swept away by the unobstructed power of every wind, animal and vegetable life quail and wither under the influence. Ireland and Scotland were in former days well sheltered by timber; but the indiscriminate destruction of the forests inflicted a great injury on these kingdoms, which however in Scotland has been partly remedied by the extensive plantations raised by the late Duke of Athol and other proprietors, who have set an excellent example, which, if followed on the exposed lands of the west, would prove a great national benefit.

Belts of plantations with a curved outline, carried along the hill-sides and the knolls, are best adapted to give the greatest amount of shelter and occupy the least ground; such is also the most ornamental style of planting. The belts should run across the strike of the prevailing wind, and the thickness be proportionate to the degree of exposure. It requires much care and knowledge to select trees suited to the soil and climate. The pineaster (Pinus maritima), the Scotch fir, and the sycamore are well adapted to bleak situations; and a valuable shrub, the tamarisk (Tamarix Gallica), grows rapidly in sandy soil on the most open part of the south-west coast: in seven years it reaches from 10 to 12 feet in height, and is feathered to the very bottom. If planted on a 5-foot bank, it forms an excellent screen, under which a plantation is rapidly raised. I have passed over large tracts of the west, where the soil is naturally good, but where a tree could not be seen for many miles; if a proper system of planting were carried out on such lands, and in Ireland, it would not only much improve the climate by raising the temperature of summer, but it would add much to the beauty of the country, giving it that rich, sheltered appearance which is now the peculiar characteristic of the midland counties.

The climate of Britain may have its defects, but they are more than compensated by the advantages it confers. The husbandman can uninterruptedly pursue his avocation at all seasons of the year; the traveller, or those who seek health or exercise abroad, can be in the saddle or on the wheels, careless of the cold of winter or the heat of summer. It perfects all the substantial necessaries of life required from the soil; and it has given an athletic frame, and impressed an energy and perseverance of character on the inhabitants, which never could have been developed amid the lassitude of an oriental clime, or beneath the rigour of the northern sky.

TABLE, showing the TEMPERATURE of FOREIGN CORN-PRODUC

Names of Places.	Lat. N.	Long. W.	Elev.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
	° ′	° ′	Feet.	°	°	°	°	°	°	°	°
Cincinnati (U.S.)	39 6	84 27	. .	32·6	31·6	43·2	53·7	63·2	70·8	75·6	73·2
Council Bluffs .	41 25	95 43	800	22·61	26·59	37·43	51·82	66·56	73·98	77·38	76·11
Fort Gipson . .	35 47	95 10	. .	45·47	41·25	53·51	61·28	72·69	78·65	81·49	83·28
Burlington . .	44 28	73 13	. .	21·39	21·46	31·04	41·84	54·57	64·59	69·80	68·66
Bloomington . .	41 26	91 2	. .	23·5	26·93	34·2	53·2	57·48	67·55	70·88	68·18
Albany . . .	42 39	73 44	130	23·94	25·07	34·89	47·83	59·75	68·05	72·04	69·93
Philadelphia . .	39 57	75 1	. .	30·08	29·40	38·78	49·45	61·18	68·65	73·92	71·51
Buffalo . . .	42 55	78 55	. .	23·41	21·14	35·49	40·7	55·29	67·45	71·55	69·99
Toronto . . .	43 40	79 22	340	25·34	23·71	30·37	43·38	53·28	60·88	66·28	66·73
Montreal . . .	45 31	73 35	. .	15·01	19·22	30·98	45·82	60·49	69·25	73·57	71·37
Paris	48 50	— 2 20	114	35·44	39·54	43·99	49·78	58·08	62·74	65·66	65·35
Toulouse . . .	43 36	— 1 26	. .	39·79	41·83	46·78	53·53	61·03	66·04	70·12	71·13
Brussels . . .	50 51	— 4 22	262	35·29	39·36	42·78	47·28	57·07	63·3	64·38	64·42
Augsburg . .	48 21	—10 53	1,470	25·95	30·76	38·14	48·02	56·62	61·21	64·63	63·43
Berlin . . .	52 30	—13 24	100	27·72	31·66	38·17	47·48	56·57	63·37	65·84	64·87
Dantzig . . .	54 20	—18 41	. .	27·45	30·78	35·24	43·41	52·07	59·27	63·59	62·9
Frankfort-on-the-Main . . .	50 10	— 8 37	330	31·46	36·68	41·54	49·10	57·74	63·5	66·07	65·73
Prague . . .	50 5	—16 46	583	27·61	31·39	40·87	52·61	60·49	65·95	69·62	68·56
Vienna . . .	48 13	—16 23	450	29·28	33·53	40·8	51·85	62·15	67·48	70·75	69·96
Cracow . . .	50 4	—19 51	607	23·94	28·15	36·30	47·77	58·57	65·37	67·03	65·77
Klausenburg . .	46 44	—23 31	1,200	31·64	42·13	36·28	49·55	57·65	64·81	66·99	66·81
Moscow . . .	55 45	—37 38	400	13·57	16·	26·76	41·72	54·46	62·38	66·40	63·12
Cherson . . .	46 38	—32 37	. .	25·23	30·96	38·21	50·7	62·06	69·89	71·40	68·7
Bucharest . .	44 27	—26 8	. .	23·99	20·30	31·73	44·33	56·32	62·56	68·16	65·17
Sebastopol . .	44 36	—33 32	. .	34·27	36·52	42·37	50·92	61·54	70·09	71·15	70·48
Warsaw . . .	52 13	—21 1	351	22·28	25·79	31·17	42·91	50·09	60·89	64·63	64·11
Constantinople .	41 2	—29 0	. .	41·18	39·20	45·86	51·8	61·34	67·64	74·12	72·32
Cairo	30 2	—31 15	. .	58·1	56·12	64·58	77·9	78·26	83·66	85·82	85·82
Messina . . .	38 11	—15 34	. .	54·21	54·21	56·66	60·58	67·21	73·87	78·46	79·09
Florence . . .	43 47	—11 15	220	41·2	44·58	50·56	59·65	65·41	71·17	76·93	75·92
Verona . . .	45 26	—11 0	. .	37·11	41·72	50·27	59·14	68·88	74·26	79·18	78·78
Milan . . .	45 28	— 9 11	720	33·22	38·3	45·88	54·66	64·09	70·68	74·75	73·58
Turin . . .	45 11	— 7 41	857	30·9	36·3	44·56	52·63	64·	68·45	72·91	73·18
Cadiz . . .	36 32	— 6 18	. .	51·4	53·73	55·21	59·64	63·75	68·16	70·27	72·86
Lisbon . . .	38 42	— 9 9	. .	52·52	53·6	56·30	59·	63·68	69·44	72·14	71·24
Jerusalem . .	31 47	—35 14	2,500	47·72	53·73	60·01	54·7	66·79	71·74	77·34	72·55
Madrid . . .	40 25	— 3 42	1,939	42·44	44·42	48·2	55·28	63·14	71·96	78·26	78·98
Bergen . . .	60 24	— 5 18	. .	35·02	36·64	37·58	44·33	51·33	56·55	60·4	58·87
Haarlem . . .	52 23	— 4 39	. .	34·32	37·29	40·82	47·62	55·06	59·68	62·82	63·28
Christiania . .	59 55	—10 45	74	20·79	21·60	30·11	39·13	55·90	58·73	61·25	59·63
St. Petersburgh .	59 56	—30 18	. .	14·74	18·68	25·5	37·18	48·52	59·95	63·91	61·16

… Countries, from Dove's Tables.—Rep. of British Assoc. 1847.

…ept.	Oct.	Nov.	Dec.	Year.	Summer Temp.	Diff. of H. & C. Month.	No. of Years.	Hours of Observation.	Countries.
	°	°	°	°	°	°			
·8	53·8	40·5	31·6	52·80	73·20	44·	6	5, 2, 9	Basin of the Ohio.
·24	53·65	38·5	24 21	51·17	75·82	54·77	5	7, 2, 9	Higher val. of the Missouri.
·61	65·95	54·12	46·20	63·21	81·14	42·03	3	7, 2, 9	Gt. Western plain of N. A.
·71	47·13	35·03	24·33	44·96	67·68	48·41	7	Sunrise, 1, 9	State of Vermont.
·2	49·3	34·6	26·88	47 91	68·87	47·38	4	. .	State of Illinois.
·38	49·2	38·07	28·28	48·2	70·01	48·10	19	N. and Y.	State of New York.
·60	51·7	40·32	30·72	50·78	71·36	44·52	8½	Sunrise, 2	
·89	48·75	37·22	27·8	46·56	69·66	50·41	2	N. and Y.	Upp. Canada. SabineMSS.
·71	45·69	36·03	27·24	44·81	64·63	45·81	5	Hourly	(37,296 Obs.)
·15	48 66	34·43	19·13	45·76	71·39	58·56	10	7, 3	Lower Canada.
·17	52·25	44·17	38·57	51·31	64 58	30·22	39	Daily extr.	Paris Basin.
·17	56·37	48·	41·99	55·15	69·09	31·34	11	9 times	Upper val. of the Garonne.
·29	51·76	43·75	39·38	50·68	64·03	29·13	10	Daily extr.	Belgium.
22	47·12	37·4	31·57	46·85	63·09	38·68	22	7, 2, 9	Upper Basin of Danube.
44	49·93	39·31	34·97	48·16	64·56	38·12	24	Daily extr.	Great Northern Plain of
08	47·05	38·05	31·8	45·64	61·92	36·14	32	6, 2, 10	Europe.
								. .	
41	49·24	40·96	34·25	49·64	65·10	34·61	20		
81	50·29	39·92	33·53	50·23	68·04	42·01	14½	8, 12, 3, 10	Basin of Bohemia.
90	51·22	40·35	33·04	51·03	69·39	41·47	60	8, 3, 10	
	47·53	36·21	29·48	47·09	66·05	43·09	20	7, 12, 2, 9, 6, 2, 10	Galicia.
72	51·53	36·03	32·88	49·5	66·20	35·35	2	7, 2, 9	Transylvania.
20	39·49	27·14	16·02	40·02	63·96	52·83	21	8, 2, 10	Great Northern Plain.
33	50·36	36·5	25·47	49·15	70·	46·17	4⅔	Daily extr.	Southern Russia.
3	49·35	42·85	33·08	46·36	65·27	47·86	2	7, 8	Plain of Wallachia.
41	53·76	44·08	37·04	52·97	70·57	36·88	10	Daily extr.	Crimea.
03	45·07	35·15	26·67	44·15	63·21	42·35	. .	. .	Poland.
48	65·48	50·72	42·44	56·47	71·36	34·92	2½	Red.	
16	72·32	62·96	61·34	72·17	85·10	29·7	1	. .	Valley & Delta on the Nile.
54	69·42	62·67	56·48	65·7	77·14	24·88	5	12 red.	Sicily.
15	60·4	50·34	45·52	59·24	74·67	35·73	12	7, 12, 11	Tuscany.
07	60·87	47·95	39·31	58·96	77·40	42·07	37	Sunrise, 1, 2, 9, 2	Plains of Lombardy.
47	56·93	47·08	36·57	55·19	73·	41·23	59	Sunrise, 2, 4	
36	54·46	42·58	33·19	53·13	71·51	42·28	30	Sunr., suns., 12, red.	Upper Valley of the Po.
17	67·1	58·8	53·58	62·06	70·43	21·46	2⅓	12, 6, red.	Southern Spain.
44	62·6	55·4	51·44	61·4	70·94	20·7	5	. .	
24	68·42	58·93	47·38	62·63	73·87	29·96	1	Sunrise, 2, 9	Syria.
	56·48	47·84	42·62	58·16	76·40	36·54	2	Daily extr.	Central Spain.
37	48·04	40·89	37·29	46·17	58·60	25·38	6	. .	Coast of Norway.
34	51·43	43·	38·25	49·37	61·92	28·96	53	Red., 8, 1, 10	Marshes of Holland.
77	43·27	31·82	27·16	41·45	59·87	40·46	7¾	Red.	
31	41·38	30·38	22·57	39·61	61·67	49·17	13	7, 2, 9	

Place between pages 58 *&* 59.

APPENDIX No. II.

Observations on the Temperature of the Surface-water of the Sea in the Bristol Channel, 1849.

Referred to in paragraph 58a.

Date. 1849.	Time of Day.	Temp. of Sea.	Temp. of Air.	State of Tide.	Wind.		Remarks.
Oct.		°	°				
1	9 a.m.	59¼	60	Low water	W.	Moderate breezes	Sunshine with clouds.
	3½ p.m.	60	60	High water	,,	,,	Ditto.
2	10¼ a.m.	60	59	Nr. low water	N.E.	Moderate	Ditto.
	9 p.m.	59	59	4½ hrs. flood	E.N.E.	Light winds	Hazy.
3	,,	59	59	4½ hrs. ebb	W.S.W.	Strong winds	Cloudy and hazy at sea.
	5½ p.m.	59	58	High water	S.W.	Fresh gales	Cloudy.
4	9 a.m.	58	55	Half ebb	N.N.W.	,,	Ditto.
	6 p.m.	58	52	High water	,,	,,	Ditto.
5	5 p.m.	56	54	4 hrs. flood	W.N.W.	Fresh breezes	Cloudy with rain.
6	8 a.m.	56	51	1½ hrs. ebb	S.W.	Strong winds	Cloudy.
	4½ p.m.	55	51	½ hrs. flood	,,	Fresh gales	Heavy rain.
7	7¾ a.m.	56	54	Half flood	W.	Fresh breezes	Cloudy with showers.
	5½ p.m.	55	52	1½ hrs. flood	N.W.	,,	Ditto.
8	9¼ a.m.	55	51	5 hrs. flood	N.E.	Fresh gales	Cloudy.
	5 p.m.	54	51	4 hrs. flood	E.N.E.	Fresh breezes	Ditto.
9	9½ a.m.	54½	49	5 hrs. flood	E.S.E.	Moderate	Ditto.
	6 p.m.	54	50	Low water	S.E.	Light breezes	Sunshine.
10	9½ a.m.	54	48	4 hrs. flood	,,	Moderate breezes	Clear.
	3½ p.m.	54	49	4½ hrs. ebb	,,	,,	Cloudy.
11	7 a.m.	53	47	1 hrs. flood	,,	Moderate	Moderate breezes.
	6 p.m.	49	52	Low water	N.E.	Fresh	Fresh and clear.
12	9¼ a.m.	48	53	Half flood	,,	Fresh breezes	Clear.
	5¾ p.m.	49	54	4½ hrs. ebb	,,	Strong winds	Cloudy.
13	8½ a.m.	52	41	1 hrs. flood	,,	Fresh winds	Clear.
	5½ p.m.	53	45	Half ebb	,,	Strong winds	Cloudy.
14	7¾ a.m.	52	44	5 hrs. ebb	,,	Strong breezes	Sunshine with clouds.
	3¼ p.m.	52	45	½ hrs. ebb.	E.N.E.	,,	Ditto.
15	7 a.m.	51	41	Half ebb	N.E.	Moderate breezes	Cloudy.
	5¾ p.m.	52	45	1 hrs. ebb	,,	,,	Ditto.
16	10½ a.m.	54	47	Low water	S.E.	Light breezes	Cloudy and hazy.
	10¾ p.m.	53	46	½ hrs. ebb	,,	,,	Ditto.
17	7½ a.m.	53	47	2 hrs. ebb	,,	Moderate	Sunshine with clouds.
	3 p.m.	53	46	Half flood	W.S.W.	,,	Ditto.
18	7 a.m.	53	50	2 hrs. ebb	,,	Fresh breezes	Sunshine; hazy at sea.
	3¾ p.m.	55	54	5½ hrs. flood	S.S.E.	Moderate	Ditto.
19	7¾ a.m.	54	53	1 hrs. ebb	S.E.	Fresh breezes	Cloudy.
20	8 a.m.	54	53	½ hrs. ebb	N.N.W.	Light winds	Ditto.
	5¼ p.m.	54	53	Half flood	W.N.W.	,,	Clear.
21	9¼ a.m.	54	50	1 hrs. ebb	,,	Fresh breezes	Cloudy; hazy at sea.
	3½	53	55	½ hrs. flood	,,	,,	Ditto.
22	7 a.m.	54	50	4 hrs. flood	W.S.W.	,,	Ditto.
	5¼ p.m.	55	54	Half flood	,,	Strong breezes	Cloudy.
23	10 a.m.	54	53	Nr. high water	W.	Stormy winds	Cloudy; hazy at sea.
	4¾ p.m.	54	53	4 hrs. flood	,,	,,	Cloudy.
24	8¾ a.m.	54	54	4 hrs. flood	S.W.	Fresh breezes	Ditto.
	5 p.m.	54	54	Low water	,,	,,	Cloudy with rain.
25	9½ a.m.	55	55	4 hrs. flood	W.S.W.	,,	Thick rain.
	3 p.m.	55	55	Half ebb	W.	Strong wind	Ditto.
26	7 a.m.	53	52	Low water.	W.N.W.	Fresh breezes	Foggy.
	5¼ p.m.	56	55	4 hrs. ebb	,,	,,	Ditto.
27	7¾ a.m.	58	58	Low water.	W.	,,	Ditto.
	5¼ p.m.	58	58	5 hrs. ebb	N.W.	,,	Ditto.

Observations on the Temperature of the Surface-water, &c.—*continued.*

Date. 1849.	Time of Day.	Temp. of Sea.	Temp. of Air.	State of Tide.	Wind.		Remarks.
Oct.		°	°				
28	8 a.m.	58	58	Low water	W.N.W.	Light winds	Foggy.
	4 p.m.	58	58	4 hrs. ebb	N.	Moderate	Ditto.
29	3¾ p.m.	58	58	2 hrs. ebb	S.W.	Moderate breezes	Hazy and cloudy.
30	6¾ a.m.	56	54	Half ebb	,,	,,	Cloudy.
	5 p.m.	58	57	Quarter ebb	,,	,,	Ditto.
31	12 noon	57	55	½ hrs. flood	,,	Fresh breezes	Sunshine with clouds.
	4¾ p.m.	56	54	High water	,,	Strong winds	Ditto.
		54·84	Mean of the month of October.				
Nov.							
10	7½ a.m.	56	53¾	1½ hrs. flood	S.W.	Moderate breeze	Clear.
	2¼ p.m.	56	55	2½ hrs. ebb	S.S.W.	Fresh breeze	Sunshine.
11	7¼ a.m.	55	51¼	Quarter flood	,,	,,	Cloudy.
	4¾ p.m.	55	53¼	3½ hrs. ebb	,,	,,	Ditto.
12	7¼ a.m.	54	50	Low water	S.W.	Moderate breeze	Ditto.
	4¾ p.m.	56	54	3¼ hrs. ebb	,,	,,	Cloudy with haze.
13	9 a.m.	56	54	5½ hrs. ebb	W.	,,	Sunshine with clouds.
	4¾ p.m.	56	54¼	5½ hrs. flood	,,	,,	Cloudy with rain.
14	7¼ a.m.	54	52	Half ebb	,,	Strong breezes	Ditto.
	3¼ p.m.	54	49	3¼ hrs. flood	N.W.	,,	Sunshine with squalls.
15	7¼ a.m.	58	48	2 hrs. ebb	,,	Fresh gales	Cloudy.
	4½ p.m.	53½	47¼	5 hrs. flood	N.N.W.	Strong gales	Cloudy with storms of hail.
16	10½ a.m.	53	47½	4½ hrs. ebb	N.	Fresh gales	Sunshine with clouds.
	4¾ p.m.	53	47	4 hrs. flood	,,	,,	Cloudy.
17	8 a.m.	52	49	1¼ hrs. ebb	N.N.E.	Moderate breezes	Ditto.
	4¾ p.m.	54	50	4¼ hrs. flood	E.	Light winds	Ditto.
18	9¼ a.m.	54	52	2½ hrs. ebb	W.S.W.	Moderate breezes	Ditto.
	3 p.m.	54	53	1 hrs. flood	,,	,,	Thick with rain.
19	7½ a.m.	54	52	5¼ hrs. flood	N.N.W.	,,	Ditto.
	4¾ p.m.	54	52	1¾ hrs. ebb	W.N.W.	,,	Cloudy.
20	7½ a.m.	53½	51	4½ hrs. flood	S.S.E.	Light winds	Cloudy with haze.
	4½ p.m.	53	51	1¾ hrs. flood	S.S.W.	Moderate breezes	Cloudy.
21	4½ p.m.	55	54	½ hrs. flood	S.W.	Fresh breezes	Cloudy with showers.
22	10 a.m.	54	51	5½ hrs. ebb	S.S.W.	,,	Cloudy.
	3¼ p.m.	54	51	Low water	,,	,,	Cloudy.
23	7 a.m.	53	51½	1½ hrs. flood	S.W.	Moderate breezes	Cloudy with rain.
	4½ p.m.	52½	51	5 hrs. ebb	W.N.W.	,,	Cloudy.
24	10¼ a.m.	54	52	4¾ hrs. flood	N.W.	Light breezes	Cloudy with haze.
	4¾ p.m.	54	52	5 hrs. ebb	N.	,,	Cloudy.
25	9 a.m.	52½	50	2¼ hrs. flood	N.N.E.	Moderate breezes	Sunshine with clouds.
26	11 a.m.	50¼	50	3 hrs. flood	,,	Fresh breezes	Cloudy.
	4 p.m.	51	50	1½ hrs. ebb	N.E.	,,	Sunshine with clouds.
27	7 a.m.	51	42	Low water	S.S.E.	Light winds	Clear.
	4½ p.m.	52½	42	2½ hrs. ebb	W.S.W.	Moderate breezes	Cloudy.
28	7½ a.m.	50	40	3 hrs. ebb	S.S.E.	Fresh breezes	Ditto.
	2¼ p.m.	51	44	5 hrs. flood	S.	Strong breezes	Ditto.
29	10½ a.m.	52	52	Low water	S.W.	Light winds	Sunshine with clouds.
	4 p.m.	51	50	5½ hrs. flood	,,	,,	Cloudy.
30	8 a.m.	51	50	3 hrs. ebb	N.	,,	Cloudy with rain.
	4½ p.m.	52	51	4½ hrs. flood	N.N.W.	Moderate breezes	Cloudy.
		53·5	Mean of the month of November.				

Observations on the Temperature of the Surface-water, &c.—*continued.*

Date. 1849.	Time of Day.	Temp. of Sea.	Temp. of Air.	State of Tide.	Wind.		Remarks.
Dec.		°	°				
1	11 a.m.	51	50	5 hrs. ebb	N.N.W.	Light winds	Hazy.
	3 p.m.	53	52	3½ hrs. flood	W.S.W.	,,	Showers and cloudy.
2	10¼ a.m.	53	55	3½ hrs. ebb	,,	Moderate breeze	Cloudy.
	3¼ p.m.	51	52	4 hrs. flood	W.N.W.	Fresh breeze	Ditto.
3	11 a.m.	51	52	4 hrs. ebb	W.S.W.	Moderate breeze	Cloudy with haze.
	4·50 p.m.	53	50	3 hrs flood	E.N.E.	,,	Ditto.
4	10¾ a.m.	51	43	3½ hrs. ebb	S.S.E.	,,	Ditto.
5	7½ a.m.	52	49	5½ hrs. flood	S.W.	,,	Cloudy.
	3 p.m.	52	48	¾ hrs. flood	,,	,,	Ditto.
6	7½ a.m.	52	44	3½ hrs. flood	W.S.W.	,,	Clear.
7	10 a.m.	52	50½	4¾ hrs. flood	S.W.	Fresh gales	Cloudy with rain.
	2 p.m.	53	51	3 hrs. ebb	S.S.W.	Moderate breezes	Hazy with rain.
8	9½ a.m.	52	48	4 hrs. flood	W.N.W.	,,	Sunshine with clouds.
	4¼ p.m.	52	49	4½ hrs. ebb	,,	,,	Cloudy.
9	10 a.m.	54	49	2½ hrs. flood	E.S.E.	Fresh breezes	Sunshine with clouds.
	3 p.m.	54	48	2¼ hrs. ebb	,,	,,	Ditto.
10	7½ a.m.	49	46	Low water	E.N.E.	Light winds	Clear.
	4¼ p.m.	50	46½	4 hrs. ebb	,,	,,	Ditto.
11	8½ a.m.	50½	46	5 hrs. ebb	S.	Moderate breezes	Cloudy.
	4¼	51	48	1½ hrs. ebb	E.S.E.	,,	Ditto.
12	9¾ a.m.	42	41½	4¾ hrs. ebb	S.S.E.	,,	Hazy.
	4¼ p.m.	52	44	4¼ hrs. ebb	S.	Fresh breezes	Cloudy.
13	8·30 a.m.	49½	43	4¾ hrs. ebb	,,	,,	Ditto.
	2½ p.m.	49	43	4¾ hrs. flood	S.S.W.	,,	Cloudy with rain.
14	7½ a.m.	52	52	3 hrs. ebb		Calm	Cloudy with fogs.
	4¼ p.m.	52	50	5½ hrs. flood	W.S.W.	Strong breezes	Cloudy with haze.
15	9¾ a.m.	52	50½	4½ hrs. ebb	,,	Fresh breezes	Cloudy with rain.
	4 p.m.	52	51	4½ hrs. flood	,,	,,	Cloudy.
16	10 a.m.	54	53	4 hrs. ebb	W.	Light breezes	Cloudy with haze.
	4 p.m.	54	52	3¼ hrs. flood	W.S.W.	Moderate breezes	Cloudy with rain.
17	9¼ a.m.	52	51	2½ hrs. ebb	W.N.W.	Strong breeze	Cloudy.
	3 p.m.	54	51	2 hrs. flood	W.	Fresh breeze	Ditto.
18	8 a.m.	53	51	5¾ hrs. flood	,,	,,	Cloudy with rain.
	4 p.m.	53	51	2 hrs. flood	W.N.W.	,,	Cloudy.
19	10 a.m.	52	48	1½ hrs. ebb	N.N.E.	Strong gales	Sunshine with gales.
	4 p.m.	50	46	1½ hrs. flood	,,	Strong breezes	Cloudy.
20	8 a.m.	52	48	5 hrs. flood	,,	Moderate breezes	Ditto.
	4½ p.m.	52	47	1 hrs. flood	E.N.E.	,,	Ditto.
21	9¾ a.m.	50	40	High water	,,	,,	Sunshine with frost.
	3 p.m.	48	39	5 hrs. ebb	,,	,,	Clear.
22	7¾ a.m.	49	32	2½ hrs. flood	,,	,,	Clear with frost.
	4 p.m.	48	32	5½ hrs. ebb	,,	,,	Ditto.
23	8¾ a.m.	47½	34	3¼ hrs. flood	,,	Fresh breezes	Ditto.
	4 p.m.	48	33	4½ hrs. ebb	,,	,,	Ditto.
24	8¾ a.m.	46	34	2½ hrs. flood	S.S.E.	Light winds	Ditto.
	4 p.m.	48	32	4½ hrs. ebb	N.E.	Moderate breezes	Cloudy.
25	8½ a.m.	48	41	¾ hrs. flood	E.N.E.	,,	Clear.
	3 p.m.	48	40	2½ hrs. ebb	,,	,,	Ditto.
26	8½	49	47½	1 hrs. flood	N.N.E.	Fresh breezes	Cloudy with rain.
	4 p.m.	49¾	47	2 hrs. ebb	N.	,,	Cloudy.
27	9 a.m.	48½	46	Low water	N.N.W.	Fresh gales	Ditto.
	4 p.m.	49¾	46	¾ hrs. ebb	,,	,,	Ditto.
28	10 a.m.	44	38	Low water	N.N.E.	Strong gales	Sunshine with clouds.
29	8 a.m.	46	39	4 hrs. ebb	,,	,,	Cloudy.
	3 p.m.	47	40	3¾ hrs. flood	,,	,,	Ditto.

Observations on the Temperature of the Surfaee-water, &c.—*continued.*

Date. 1849.	Time of of Day.	Temp. of Sea.	Temp. of Air.	State of Tide.	Wind.		Remarks.
Dec.		°	°				
30	7¾ a.m.	47	47	3¾ hrs. ebb	E.N.E.	Fresh breezes	Clear.
	4 p.m.	47	40	4½ hrs. flood	,,	Moderate breezes	Ditto.
31	8¼ a.m.	46	34	2¼ hrs. ebb	S.S.W	Light winds	Clear with frost.
		50·3	Mean of the month of December.				
1850 Jan.							
1	8¼ a.m.	50	44	4 hrs. flood	W.N.W.	Moderate breezes	Cloudy.
	4 p.m.	50	44	Half flood	S.S.W.	Light winds	Ditto.
2	8½ a.m.	47	43	½ hrs. ebb	W.S.W.	,,	Clear.
	3 p.m.	49	47	¾ hrs. flood	,,	,,	Hazy.
3	8 a.m.	48	48	5½ hrs. flood	N.W.	Moderate breezes	Cloudy.
	4 p.m.	48	48	½ hrs. flood	W.	Light winds	Hazy.
4	9¾ a.m.	48	48	5½ hrs. flood	W.S.W.	Moderate breezes	Cloudy with haze at sea.
	4 p.m.	45	48	Low water	W.N.W.	Fresh breezes	Hazy at sea.
5	10 a.m.	47	42½	5 hrs. flood	N.	Strong breezes	Sunshine with clouds.
	4 p.m.	47	42	5 hrs. ebb	N.W.	Fresh breezes	Cloudy.

Note by Mr. Pusey.

This paper appears to me one of the most valuable contributions yet made by science to practical agriculture. It clearly establishes the causes of the difference pointed out many years since, by myself, between the farming of our western and eastern districts. It shows why it is impossible for English to vie with Scotch farmers in the growth of turnips and oats, or Scotch with English farmers in the growth of barley and mangold. It affords additional caution as to dogmatic positiveness in laying down general rules for farming; but it also gives substantial information enabling us, by consulting the climatic situation of a district, to say in some degree beforehand what system of farming will or will not suit it. Thus, as to irrigation, the importance of which is now recognised, I was enabled, from a general knowledge of the mildness of the winter in Argyleshire and Kerry, to anticipate with some confidence its success in those counties; but the observations of Mr. Whitley place that success now beyond doubt. It is also clear how much may be done for our climate by drainage. Fogs and even rain appear to be produced *often* by the mere cooling down of the moisture which has risen into the air from the surface of the land, which moisture becomes prejudicial in fog or beneficial in rain. Improvement has already arisen, and seems to be advancing, in the diminution of fogs, but as to rain, though the doubt may seem visionary, there does appear to me to

be some risk that when all England is thoroughly drained, we may gain a general improvement indeed of climate for corn crops, while our grass and turnips may suffer from the change. Already it is often difficult to grow turnips in our dry inland counties, such as Berkshire. In the Eastern counties the sea breezes bring showers for the turnips when they are most wanted, that is, in summer. Hence probably their superiority in the cultivation of those roots, the certainty of success encouraging the use of artificial manures.

Ph. P.

II.—*On the Pūrik Sheep of Thibet.*

Communicated by Command of H.R.H. The Prince Albert.

From Colonel the Hon. C. B. Phipps.

Sir,—Last year some sheep from Thibet—one ram and three ewes—were presented to the Queen, and were by Her Majesty's command turned out upon the farm at Osborne. The extent to which these sheep increased and throve appeared to His Royal Highness The Prince so satisfactory, that he directed me to call upon Mr. Toward, Her Majesty's bailiff, for a detailed report, thinking it might be interesting to the members of the Royal Agricultural Society. That report I now, by His Royal Highness's command, enclose to you. You will observe that the increase in 11 months is without one instance of twins.—I have the honour to be, Sir, your obedient humble servant,

C. B. Phipps.

Buckingham Palace, Feb. 14, 1850.

Sir,—The Thibetian sheep arrived here in March, 1849—one ram and three ewes. The ram (Runjeet Singh) and one ewe (Ranee) were about two years old; the other two ewes (Tibetta and Sultania) were tegs about a year old:—

Ranee	lambed April	12,	and again	October	8
Tibetta	,,	,, 22,	,,	,,	24
Sultania	,,	,, 25,	,,	,,	22

Tibetta's lamb, born April 22nd, gave birth to a ewe-lamb on the 8th instant. We have now 11, old and young—1 ram and 10 ewes. The three old ewes and the remaining two, born in April, appear to be in a state of gestation, one of the latter in an advanced stage. I think it would be better if they were not allowed to breed so young, as it must impede their growth. As regards their qualities for laying on meat, I have as yet had no opportunity to prove them; the ewes have nearly the whole

time been giving suck; they are in good stock-order, and have every appearance as if they would fat kindly, but from their size can never attain great weight. I suppose when fat they would average from 32 to 40 lbs. each. I think from two to three may be kept at the same cost as one common sheep. The texture of the wool is good in quality, and according to their size they produce a fair quantity; the coats on the back of those lambed last April are remarkably thick and close; cold could hardly penetrate. In their native country they are clipped twice a-year; perhaps we ought to do the same here. I would recommend trying part, if not all, another year. They have been fed on hay with a few Swede turnips during the winter, entirely exposed to all weathers. There is a shed, but they seldom go into it. I am quite satisfied that they will live and do well on the same food as other sheep, though we were told that they must be kept on dry hay.—I am, Sir, very respectfully, your most humble servant,

ANDREW TOWARD.

Osborne, Feb. 13, 1850.

The flock now numbers 15—1 ram and 14 ewes; it is rather remarkable that out of so many lambs there is not one male. I had them clipped on the 20th of last month; the wool weighed as follows:—

Fleece of Ram	5 lbs.
3 Old Ewes	8
3 Teg Ewes	6½

Osborne, May 12, 1850. A. T.

Note by Mr. Pusey.

This very curious breed of sheep was discovered by Mr. Moorcroft during his adventurous exploration of Thibet about thirty years since. He spoke of them in a letter written during that journey, and published by the Royal Asiatic Society in their Transactions.* Falling a victim to the hardships of his expedition, he has left us no further account, nor can I find any fresh description of these sheep by any subsequent writer.

The original letter of our unfortunate and adventurous countryman, throwing light also on the agriculture of a wild district, that lies at the northern foot of the loftiest mountains in the world, beyond not the Himalayas only, but the general range of European enterprise, though immediately adjoining the scenes of our late Indian victories, will be read with interest even now.

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* Vol. i. p. 49.

"The novelties which had already met my view in natural history are so great as might swell a letter to a volume, and divert me from its practical objects—a breed of sheep of *Ladakh* (which ought, perhaps, to have precedence in mention), when at full growth has scarcely acquired the size of a Southdown lamb of five or six months; yet in the fineness and weight of its fleece, and in the flavour of its mutton, added to its peculiarities of feeding and constitution, yields not in merit to any race hitherto discovered. Perhaps the dog of the British cottager is not so completely domiciliated as is the *Pūrik* sheep of this country. In the night it finds shelter either in a walled yard or under the roof of its master; and frequently in the day picks up its food on a surface of granite rock, where the eye of the cursory inquirer can scarcely discover a speck of vegetation, though closer investigation shows stunted tufts of wormwood, hyssop, bugloss, and here and there a few blades of a dwarfed grass. But the indefatigable industry of the animal detects and appropriates substances so minute and uninviting as would be unseen or be neglected by ordinary sheep, or those of larger breed even in this country. Almost all the land round this capital is under tillage for wheat and barley, and in lucerne; but the harvest will not have been two months off the ground, and a single blade of vegetable substance shall not be discovered—not a stem of stubble, nor a crown of lucerne. The stubble is bitten off by the common cow, the *Tho* (a hybrid between the *Yak* male and the cow), and the shawl-goats; whilst the ass not only devours the stock of the lucerne, but by pawing lays bare the taproot of the upper part, of which he generally gets about three or four inches."

This close-feeding is certainly a bad specimen of stock-keeping, and of farming also. It may very likely, however, arise from a tenure of land such as that of our common-fields, on which even yet stock is allowed by law an unlimited range over the young clovers in autumn. Presently we shall find what speaks better for Ladakh farming. Mr. Moorcroft proceeds to describe the singularly domestic habits of the *Pūrik* sheep:—

"The Pūrik sheep, if permitted, thrusts its head into the cooking-pot, picks up crumbs, is eager to drink the remains of salted and buttered tea or broth, and examines the hands of its master for *lattro* (barley flour), or for a cleanly-picked bone, which it disdains not to nibble. A leaf of lettuce, a peeling of turnip, the skin of an apricot, are its luxuries. The coarse black tea of China forms the basis of the nourishment of the inhabitants of this ill-governed country, and its use is conducted with the utmost frugality. Rubbed to a powder and tied in a cloth, it undergoes frequent boilings; and when it has given out the whole of its colouring matter—a process rather tedious—the residue falls to the share of the sheep.

"I have been minutely tedious upon their acquired habits of feeding, as introductory to the conclusion that there exists not a cottager in Britain receiving no parochial relief who might not keep three of these sheep with more ease than he now supports a cur dog; nor a little farmer who might not maintain a flock of fifteen or twenty without appropriating half-an-acre exclusively to their use. They would derive support from that produce which now either wholly runs to waste or goes to the dunghill in a raw, unprofitable state; whereas, by giving sustenance to the sheep, it would be animalised, and improved as manure."

This is, perhaps, a doubtful anticipation of Mr. Moorcroft's.

He proceeds, however, to detail a practice which singularly agrees with the most modern processes of improved agriculture:—

"This point is so well understood here that sheep are bought in some parts of *Ladakh*, from grazing countries in which there is no tillage, merely for their dung, &c. during winter. They are placed in small yards, of which the floor is bespread with a coating of soil, such as it is, and are fed with lucerne hay, given with such regard to quantity that within two or three hours not a stem nor a leaf remains; and this is repeated in such a way as to prevent the smallest possible waste. So soon as the stratum is sufficiently saturated with urine and dung it is carried off, and a fresh coating is given.

"To return to the Pūrik sheep, it gives two lambs within twelve months, and is twice shorn within that period. The clip may afford three pounds in the annual aggregate, and the first yield is fine enough for tolerably good shawls."

Such is Mr. Moorcroft's account of these curious sheep, to which no further information has been added until they were successfully reared at Osborne. They are interesting, both in a scientific and an agricultural point of view. It is still a question,—What breed of wild sheep, if any, is the original stock of our domestic sheep? some having supposed them to spring from the Siberian *Argali*, and some from the African *Muzmon*. Naturalists now incline towards the Muzmon. But it is remarkable that the sheep carried by the Spaniards to America, and now apparently wandering masterless over the Cordilleras, bear lambs twice in the year. Azzara says that the ewes there yield at least three lambs every year. They must be supposed in this as in other particulars to revert, like the horse and the ox in those countries, towards their original type. Now the *Muzmon* is said to bring forth but once in the year, but the *Argali* twice. Here then is some indication of an eastern origin for our sheep. Our own origin was certainly from a country tenanted by the *Argali*, the neighbourhood of the Hindù-kush. But whether our Indo-Germanic ancestors came in a nomade state bringing their flocks with them, or whether, as the history of their language seems to show, they had passed beyond that state, and came therefore as conquering bands to appropriate the wealth of the primitive Europeans, is a question which admits of course no positive answer. If the latter supposition be true, the original cultivators of Europe, the Iberians, whose gallant descendants the Basques remain to this day pent up in the narrow corner of Biscay, might naturally have brought their sheep with them from Africa, by which road they are themselves supposed by Bishop Thirlwall to have arrived in Europe. The chief scientific interest turns upon the great question in physiology, what amount of variation constitutes a distinct species, and what amount may be supposed to arise from natural or artificial circumstances. Besides the

many distinctions in sheep as to wool or hair, size, horns, &c., we found in the last Journal a breed, the Herdwick, with an additional rib. The *Pūrik* again presents a difference in one of the most important functions of animal life. The size of the Argali, little less than that of a red-deer, is supposed to be too great for the parent stock of our domestic sheep. But the *Pūrik* sheep, which is yet smaller, is found near the wild *Argali*, and of domestic breeds seems alone to resemble it in fertility. After all, there is a distinct breed of wild sheep in the neighbourhood of the Himalayas, resembling in size our domestic sheep, a preserved specimen of which may be seen in the British Museum. Great doubt must therefore still hang over the whole matter.

Neither of course can the practical question, whether the *Pūrik* sheep be adapted to English farming, be as yet answered positively. They have thriven admirably at Osborne; but they have not thriven on the Welsh mountains, appearing to suffer there from excess of rain. Nor is this to be wondered at. For the extraordinary valley from which they come is said indeed to be as high as the summit of Mont Blanc, but it is almost entirely deprived of rain, though snow falls occasionally. Hence the arid character of its vegetation, and hence the impossibility of cultivating its plants in England. Our southern counties, however, appear to be sufficiently dry, if the breed merit culture. The diminished number of ewes to be sustained in proportion to the produce, must of course be a source of economy. The quality of the mutton is beyond dispute. If they retain their size, the meat might, at least, compete with house-fed lamb; and there is little doubt that their size might be increased by generous food, in a few generations. As to their early maturity, we have no distinct knowledge, so far at least as regards their disposition to fatten. But maturity is generally in proportion to the frequency of parturition, as is clearly seen in the two extreme cases of the elephant and the rabbit. In a scientific point of view, it would also be worth while to observe whether the period of gestation be the same as in ordinary sheep, namely, five months, a period which would leave the ewe only two months in the year free from that process, scarcely enough, it would appear, for the nutrition of the offspring. Taking into consideration that this breed comes from a race of men who, however bleak their abode, are evidently good farmers, and that meat of fine quality is now the principal object of English farming, it appears that there is much encouragement to the further trial of this interesting breed of sheep.

Ph. Pusey.

III.—*On the Absorbent Power of Soils.* By H. S. Thompson.

To Mr. Pusey.

My dear Sir,—Professor Way's lecture on the power possessed by the soil of absorbing the salts of ammonia, potash, and other substances, has naturally excited a good deal of attention, and I have great pleasure in sending, as you suggest, an account of my experiments on this subject for publication in the next number of the Journal. They were made in the summer of 1845, and it was my intention to have published them long ago; but I was unwilling to send them before the public in an incomplete state, and I have never found leisure to complete the series I had chalked out. About two years ago I communicated a very brief outline of the results obtained to Professor Way and Mr. Huxtable, and the former gentleman has, I understand, followed up the subject and obtained numerous additional facts of great importance to agriculture.

The experiments were undertaken in consequence of the very general endeavour that was then being made to prevent the escape of ammonia from tanks and manure heaps by the use of sulphuric acid, either alone or in combination, as sulphate of lime, sulphate of iron, &c. Large quantities of sulphate of ammonia were thus formed, and as I was aware that the soil had a certain power of retaining ammonia, I was anxious to test the extent of this power, and to ascertain whether it also extended to the sulphate, as if not, the use of sulphuric acid as a fixer, though preventing the escape of ammonia in a volatile form, would have been objectionable from its forming a highly soluble salt, that would be readily washed down into the subsoil or carried off in drains.

I had also another object in view. Having observed the great waste of volatile and soluble fertilizers which occurred in ordinary farm practice by carting manure into large heaps some months before applying it to the land, I was desirous of ascertaining whether it would be safe to plough manure in at any time during the winter when it was taken out of the yard.

In conducting this inquiry, I was fortunate enough to obtain the assistance of Mr. Joseph Spence, of York, by whom the experiments were worked out, and his high chemical attainments enable me to speak with a degree of confidence of the results obtained, which I could not have done had they been entirely my own.

My first object was to place the soil to be operated on in circumstances which should approximate as nearly as possible to its state in the field. Glass percolators $2\frac{1}{2}$ inches in diameter were selected, and a portion of the cultivated soil of one of my fields (a light sandy loam of good quality, lying on the new red sandstone

formation) was placed in two of the percolators, forming in each a column 6 inches deep. They were labelled A and B. The soil was moist, but not wet. Ten grains of sulphate of ammonia dissolved in ten drams of distilled water were intimately mixed with the soil (A). Ten grains of sesquicarbonate of ammonia were similarly mixed with (B).

We now had before us two portions of soil, one of which represented land highly manured with sesquicarbonate of ammonia; a salt abounding in well-made farmyard manure, and forming its most valuable ingredient. The other represented land equally highly dressed with that salt of ammonia which is formed where tanks or manure heaps are treated with sulphuric acid, gypsum, &c. The first object was to ascertain the effect of heavy rain falling on land thus circumstanced: accordingly 8 oz. of water were poured slowly on the surface of both A and B. These 8 oz. formed a column 3 inches deep, exceeding therefore in amount the heaviest continuous fall of rain which is ordinarily experienced in this country. A considerable portion of this was retained by the soil, and when 4 oz. had passed through, as it appeared that little more was likely to follow, these 4 oz. were in each case experimented on as follows:—

A. Tested with reddened litmus and found to be alkaline, neutralized with sulphuric acid, evaporated nearly to dryness, during which a large flocculent precipitate was formed: precipitate and filter thoroughly washed with dilute alcohol: insoluble matter remaining on the filter dried and heated to redness. This weighed 4 grains, and proved to be chiefly gypsum. The portion of the precipitate dissolved by the alcohol amounted to 3 grains, of which $2\frac{4}{10}$ grs. sulphate ammonia. The remaining $\frac{6}{10}$ gr. were ascertained to be sulphates; but as the inquiry was for the present confined to the ammonia question, the analysis was not carried further.

B. The first 4 oz. which passed through were neutralized with muriatic acid and evaporated: a very slight flocculent precipitate showed itself, which was increased on adding two or three drops of dilute sulphuric acid. Treated with alcohol: the insoluble matter left on the filter weighed 1 gr. (gypsum). The alcoholic solution on evaporation left 4 grs., of which $1\frac{3}{10}$ were muriate and sulphate of ammonia. These results, when given in a connected form, show that—

No. 1.

	Grains.	
A gave	4·	gypsum.
	2·4	sulphate of ammonia.
	·6	other sulphates.
B	1·	gypsum.
	1·3	muriate and sulphate of ammonia.

This was a complete surprise. The large proportion of gypsum obtained from A (4 grs.), when compared with that from B (1 gr.), showed that a considerable portion of the sulphate of ammonia mixed with the soil had been decomposed, and that this process was in some way connected with the presence of lime in the soil, as the sulphuric acid was washed out in combination with lime. To test the extent to which this process might be carried under favourable circumstances, the experiment was repeated as follows :

Portions of the same soil were placed in the percolators to the depth of 8 inches. Ten grs. sulphate of ammonia were intimately mixed with the soil in one (A), ten grs. of the sesquicarbonate with that in the other (B). Three fluid ounces of water were poured upon it, and two similar portions at intervals of three hours. The whole of the filtered liquid was returned upon the soil at the end of twelve hours, and the same process repeated at the end of the following twelve hours; and when it had again passed through the soil, successive portions of water amounting to 8 ounces more were passed through. The whole of the filtered liquid was neutralized with muriatic acid and evaporated nearly to dryness, then treated with alcohol and filtered. The precipitate collected on the filter weighed $6\frac{3}{10}$ grs., the whole of which, with the exception of a mere trace, was gypsum. The alcoholic solution on being evaporated and heated to redness gave 1 gr., chiefly mur. magnesia; a mere trace of ammonia was found in the solid matter derived from the alcoholic solution.

B. The same process was repeated with the following result :—

Insoluble in alcohol $\frac{1}{10}$ gr. nearly all gypsum.

The alcoholic solution evaporated and heated to redness gave $2\frac{1}{2}$ grs. (a slight trace of ammonia perceptible, apparently not more than in A). The $2\frac{1}{2}$ grs. being dissolved in water and treated with sulph. ammon. and alcohol, gave a copious precipitate of sulph. lime, which being separated, the solution was treated with ammonia and phosphate of soda, giving a precipitate of ammonio-phosphate of magnesia.

No. 2.

	Grains.	
A	6·3	sulphate of lime.
	1·	muriate of magnesia.
B	·1	sulphate of lime.
	2·5	muriates of lime and magnesia.

It thus appeared that when the absorptive powers of the soil were fully called into play, by passing the filtered liquid repeatedly through the percolators, the whole of the ammonia was retained by the soil, whether applied in the form of sulphate or sesquicarbonate. The cause of its retention will be again adverted to

after relating the experiments which were next tried with a view to ascertain whether this newly discovered absorptive power was possessed by other varieties of soil.

No. 3.

The soil next operated on was a specimen of black soil (from the bottom of an old stick heap), consisting chiefly of decayed vegetable matter; 10 grs. of sulph. and sesquicarbon. ammon. were used as before, in A and B respectively, and the process above described repeated with the following results :—

	Grains.
A	5·8 sulphate of lime.
	·3 silica.
	A trace of sulphate of ammonia.
B	·8 sulphate of lime.
	·2 silica.
	3·8 salts of ammonia.

This instance is chiefly remarkable for the large quantity of soluble silica, and for the very perfect retention of ammonia, where the sulphate was used, and the considerable quantity which washed through when applied as sesquicarbonate. The abundance of decayed vegetable matter will account for the silica; the other fact is more difficult to explain.

No. 4.

A strong clay soil. The apparent influence of lime in aiding the decomposition of the salts of ammonia was borne in mind when selecting a specimen of strong clay: and the one here experimented on had been in grass for a great length of time and not limed within the memory of man.

The difficulty of getting any quantity of liquid to filter through a really strong clay is such, that though eight ounces of water were poured into the percolators, nearly three weeks elapsed before three ounces had passed through, and this quantity was therefore experimented on.

The result was as follows :—

	Grains.
A	1· sulphate of lime.
	·5 organic matter.
	Trace of ammonia.
B	·5 organic matter.
	Trace of ammonia.

The very small quantity of mineral substances obtained from the water filtered through clay was so remarkable as in the first instance to cause the result to be unrecorded, on the supposition

that some accidental circumstance must have occurred to vitiate the experiment, and it was repeated with every attention and care. The result is given above.

My main object in making these experiments had now been attained, and I had convinced myself that either sandy, clayey, or black vegetable soils possessed the power of retaining a much larger amount of ammoniacal salts than they received in the most liberal manuring.*

It had also been shown that sulphate of ammonia was quite as easily retained by the soil as the sesquicarbonate. A close examination, however, of the foregoing experiments will show us that great care is requisite in their application to practice. By comparing, for instance, Nos. 1 and 3, we see that though the soil has a greater power of retaining ammonia than can, under ordinary circumstances, be required for agricultural purposes, still that the extent to which this power is called into play depends in great measure on the mode in which the ammoniacal dressing is applied. In No. 1, where water was allowed to pass once only through a light sandy soil, it was found to carry away with it from A about a fourth part of the sulph. amm., and from B a considerable portion of the sesqui-carbonate; whereas in No. 3, where the water after passing through the same description of soil was twice returned upon it, the *whole* of the ammoniacal salts were retained, though the soil was washed with repeated applications of water.

If with these results before us we try to arrive at what actually takes place when manure is applied to land of this description, we should have to bear in mind that though the quantity of ammonia per acre is much less in the manure than in the experiments above described, yet that in consequence of the practical impossibility of distributing manure uniformly through the cultivated soil, some portions of the land receive much more than the average dressing, and in each small lump of farmyard manure, guano, &c., a considerable amount of soluble salts will be found. It must also be remembered that as manure is usually ploughed in to the depth of 3 or 4 inches at least, the solution of the above-mentioned salts when washed by rain has a very limited depth of cultivated soil to filter through before it arrives at the subsoil: when there, it is very problematical whether the roots of plants would be able to reach it, even if the subsoil should contain the requisite ingredients for arresting its downward progress. It has been shown that returning the filtered water upon the soil en-

* The weight of the column of soil operated on (8 inches deep) was 2 lbs., and to this 10 grains of the carbonate or sulphate of ammonia were added, which is equivalent to an application of 18½ cwt. per acre.

tirely deprived it of the salts which were only partially retained by the first six inches of soil it passed through. It is therefore fair to conclude that if the depth of soil in the percolator had been sufficiently great, the whole of the ammonia would have been retained at the first operation. Hence we see the importance of increasing the depth of cultivated soil through which the soluble parts of manure have to filter before escaping to the subsoil. This does not apply with equal force to clay soils, both from the much greater slowness with which any liquid passes through them, and from their greater apparent power of retaining mineral matters. In Experiment 4 scarcely any mineral substance was obtained from the water, though the clay through which it had filtered was highly charged with ammoniacal salts. This soil, from not having been limed for a long period, was expected to be deficient in calcareous matter, but on examination lime was found to be present in tolerable quantity. The practical inferences that I drew from this inquiry were as follows :—

1. That clay soils might be manured a considerable time before sowing without loss.

2. That light shallow soils should not be manured long before sowing; should not be heavily manured at one time; and the manure should be kept as near the surface as practicable without leaving it uncovered.

3. That it is desirable to deepen the cultivated soil of all light land, as it thus gives it a greater power of holding manure.

The power of the cultivated soil to decompose and retain salts of ammonia has here been pointed out: no clue, however, has been furnished to the mode in which it is accomplished. It seemed possible that it might be due to the carbonic acid which is taken up by water when passing through cultivated soil, and which forming and carrying with it bicarbonate of lime might, when coming in contact with sulphate of ammonia, decompose it, forming sulphate of lime, which filtered through with the water, and carbonate of ammonia, which all soil has apparently the power of absorbing and tenaciously retaining. It is true that this is supposing a reverse action to take place from that which is observable when sulphate of lime meets carbonate of ammonia in solution (as in liquid manure tanks, where gypsum is used) and forms sulphate of ammonia and carbonate of lime; but unexpected combinations so frequently occur in chemistry, especially where, as in the soil, other substances are present, that it seemed desirable to try the experiment, and accordingly a portion of the soil used in Experiments 1 and 2 was deprived of its carbonic acid by being spread out in a thin layer and dried at a temperature of 200°.

The percolators were filled to the depth of 8 inches with the

soil whilst still hot, and 10 grs. sulph. and sesquicarb. amm. dissolved in 10 drams of water, poured over the surface of A and B respectively. Eight oz. of boiled distilled water (cold) were immediately added to each. The soil being dry, retained a large portion of the water, but 2½ oz. were obtained to operate on, and the following result obtained by the process before described: —

	Grains.
A gave	1·2 sulphate of lime. ·1 sulphate of ammonia.
B gave	Trace of ammonia and organic matter.

If this be compared with Experiment 1, where water was, as in this instance, passed once only through the same description of soil, it will be seen that after the drying process, which bore a considerable resemblance to the ordinary agricultural operation of fallowing, the soil seemed to have acquired a still greater power of retaining ammonia than before. The mode in which it was effected, however, had no additional light thrown upon it.

The next experiment I tried, and the last that I shall mention on this occasion, was one to ascertain whether the affinity of the soil for salts of ammonia extended to other salts. Ten grains of common salt were mixed with a portion of the soil last mentioned, and water poured upon it till 12 oz. had passed through; on evaporation 9 grains of salt were indicated by its equivalent of chloride of silver being obtained. Nine-tenths of the salt applied were thus washed out unchanged by the first 12 oz. of water which passed through the soil; and the inference is clear, that if the application of common salt be of any service to light land, the benefit can only be of a very temporary nature, as a few rainy days will wash it all out.

This set of experiments is very imperfect, but it suggests many interesting questions which I hope to have leisure to follow up ere long, and in the mean while the results obtained have furnished me with useful practical hints, and may perhaps be regarded with some interest as the first discovery of a highly important property of soils, the knowledge of which can hardly fail to be beneficial to agriculture.

Yours, very truly,

H. S. Thompson.

Moat Hall, June, 1850.

IV.—*On the Farming of Sussex.* By John Farncombe.

Prize Report.

This county, of 1,400,000 acres, and between 300 and 400 parishes, contains a great variety of soils and systems of usage, which consequently render it too difficult to describe in particular; but having been bred a farmer, and having practised in different parts of the county on a great variety of soils and systems applicable thereto, having had twenty-five years' practice as a valuer, with the advantage also of being employed by the Tithe Commissioners as their usual local agent for the county, in reporting on the agreements for the Commutation of Tithes; and having been likewise extensively engaged in the apportionment of the rent-charges, I am induced to offer to your notice my experience, and to report on the Farming of Sussex. I shall begin by dividing the county into three districts. The first comprises

South and West Downs, which rise towards the east at Southborne, and continue westward as far as Hampshire,—southward by the places named as the northern boundary of No. 2, and northward by the great valley of the Weald.

The *soils* on this range are various, but generally kind and principally of chalk quality, some flinty, a small portion sandy, and the smallest portion of all adhesive and black land.

The *systems* of farming, like the soil, vary very much and generally according to the proportion of the arable to the meadow and pasture. Where the arable land is in much the lesser proportion the general system is in thirds, viz.—

One-third wheat.
One-third barley.
One third in equal proportion of seeds to mow and feed and of green fallow for sheep-feed.

In cases where the proportion is more equal, generally in fourths, viz.:—

One-fourth wheat.	One-fourth seeds.
One-fourth barley.	One-fourth fallow for sheep-feed.

Where there is less meadow and pasture, in fifths, viz.:—

One-fifth wheat.	One-tenth seeds.
One-fifth barley.	One-tenth oats.
One-fifth seeds.	One-fifth fallow.

And in some very few instances in sixths, viz.:—

One-sixth wheat.	One-twelfth oats.
One-sixth barley.	One-sixth fallow.
One-sixth seeds.	One-sixth sainfoin.
One-twelfth ditto.	

The above systems are those in general use; the adoption of them varies of course according to the proportion of the quality of soil and the local circumstances under which they are situated, There are some instances in large concerns in which the same system would not be desirable to be practised throughout, and consequently an incorporation of systems occurs.

This district is applied to the purpose it is so eminently calculated for—the production of the justly esteemed South Down sheep. The usual course of maintaining the flocks is in the proportion of three ages, 1, 2, and 3 years old. The third portion of the ewe flock is drafted, on or before Michaelmas, for sale, with the lambs, (exclusive of those required for keeping up the flock,) and sold at the fairs held at convenient times and places. The tegs, which are now eighteen months old, supply the place of the drafted ewes. The flocks are usually lambed down about the latter end of March, that being found the time best suited to avoid the inclemency of the weather in exposed situations, and likewise to meet the provision of food made for them. Three weeks after lambing they are collected and put to fold, generally on the arable lands, the manure being very valuable. Indeed it may be calculated at quite one-fourth of the return made by the flock, viz.:—if 100 ewes produced 100*l.*, the manure deposited by them would be valued at 25*l.*, and so in proportion, and hence it becomes the occupier's interest to keep them well, in order to have his land properly manured. A good, clean clover-lay, folded in the autumn, is generally the most productive part of the wheat crop. Rape is the principal provision for autumnal feeding, which is generally commenced being fed off about the middle of September, and continued till near Christmas for a wheat crop. The sheep generally thrive very fast on this till the frost comes, when they require some portion of hay or old grass with it. About forty years ago the feeding of sheep with hay and water, shut up entirely in yards, was begun, and found to succeed so well that it is continued by some, and partially by the generality of flockmasters. I have kept 500 ewes in lamb this way for more than three months after Christmas, and had them in very high condition with plenty of milk on their lambing down. This may be supposed a very expensive mode of keeping a flock; but when I explain that my occupation consisted of four-fifths of cultivated land of not more value than 12*s.* per acre on the average, 40 acres of which in sainfoin were more than sufficient to produce this quantity of hay, it may be thought not a very expensive, but very profitable mode of applying such land. Having represented the general provision under the flock system to be in rape for autumnal feeding, and the reason for this being, that it is a good preparation for wheat, I

have only to add that, for the winter, a small portion of turnips and mangold are grown for cattle and sheep, which are generally drawn off the land which is sown with wheat or other corn; but it may be quoted as a very small portion of the preparation, being very unkind for wheat and unhealthy for breeding ewes. A very experienced farmer (a neighbour of mine for many years) remarked, respecting turnips, that if you had an extra quantity of hay you were desirous of consuming, he thought it might be desirable to raise some turnips to encourage the appetite of the animals, as there was no satisfying quality in them. He planted cabbage (Drumhead) instead, which continue to be raised to a considerable extent for working cattle, being a much more certain crop (no fly to contend with), as well as being much more nutritious. He observed with what advantage I had for several years, in the same parish, raised this plant in preference to any other for at least six months in the year in maintenance of cows kept for milk near Brighton from the adjoining parish of Rottingdean. This is still continued, and also now adopted by almost all the cowkeepers as the principal winter provision for milk.

On Sheep-breeding.—Having been for many years not unsuccessful as a South Down sheep-breeder, I may venture a few remarks on this subject; and first, I shall bring to your notice that most distinguished and indefatigable character, the late John Ellman, Esq., of Glynde, near Lewes, deserving of remembrance for his improvement of this most valuable animal. I was resident near to Glynde, and consequently had the opportunity of observing how Mr. Ellman managed his flock; and I feel I shall not be doing justice to his merits if I do not state the perfection to which he brought his sheep. I have competed with some of the most eminent breeders from other counties, the Duke of Bedford, the Earl of Bridgewater, Sir John Sebright, Mr. Boys, and many others whose blood was almost entirely from Glynde, and who displayed the benefits of pure breeding. Nay, I state that in fifty years' experience I never knew a flockmaster in the county or out of it who had better sheep than others, but the improvement was to be traced to Glynde; and this most valuable blood still remains with the son at Landport, near Lewes. The mode adopted, and still continued, which produced so much perfection, is in the choice of the ewes to the rams, and the constant attention to the produce from such selections. This should be practised annually by every flockmaster, who might thereby much improve his flock. As one ram only is necessary for 100 ewes, so would the expense be small and the trouble little for him to be always certain of the sort he is breeding from; but when five rams, perhaps of different character and blood, are

used indiscriminately amongst 500 ewes, such uncertain breeding renders it impossible that he can make any selection from them to be depended on for stock; this, with hard keeping, accounts for the now generally inferior quality of the South Down sheep.

I must not pass over in silence the mistaken practice generally followed in this district of sowing too much wheat, a portion of which is illtimed, sparingly manured, and therefore on such soils not to be calculated on to produce profitably. It is better to confine the quantity sown to that which can be done well, and improve the flocks in condition, by growing more green keep for them; thus raising also the condition of the land, and eventually increasing the yield of corn. And here I propose some calculations which I hope may be useful as being the soundest mode whereby occupiers can ascertain what quantity of sheep or stock can be kept in good and profitable condition. The way to apply them is to value the produce to arise, exclusive of corn, from the land according to its quality, and the result will give the amount of money to be thus obtained. *Thousands of acres on these downs, I believe, may be profitably cultivated, which produce now little but heath and furze.* I give, as under, examples of the best systems in support of my opinions.

No. 1.—Farm supposed to be 240 Acres.

	Acres.	Acres.		£.	s.	d.
Arable	80	20	Barley and wheat	0	0	0
Down pasture	160	20	Seeds, to mow and feed	50	0	0
		20	Oats	0	0	0
	240	20	Fallow for rape and turnips	50	0	0
		160	Sheep-pasture	80	0	0
		240		180	0	0

No. 2.—Farm 240 Acres.

Arable	80	16	Sainfoin	40	0	0
Down pasture	160	16	Barley and wheat	0	0	0
		16	Seeds to pasture	40	0	0
	240	16	Oats	0	0	0
		16	Fallow for rape	40	0	0
		160	Sheep pasture	80	0	0
		240		200	0	0

No. 3.—Farm 240 Aeres.

Arable	120	20	Sainfoin	50	0	0
Down pasture	120	20	Barley and wheat	0	0	0
		20	Pasture	50	0	0
	240	20	Ditto	33	6	8
		20	Oats	0	0	0
		120	Down pasture	60	0	0
		240		243	6	8

No. 4.—Farm 240 Acres.

	Acres.	Acres.				£.	s.	d.
Arable	160	26	2	6	Sainfoin . .	66	13	0
Down Pasture	80	26	2	6	Barley or part wheat .	0	0	0
	240	26	2	6	Seeds to pasture	66	13	0
		26	2	6	Ditto ditto .	44	8	0
		26	2	6	Oats . .	0	0	0
		26	2	6	Fallow . .	66	13	0
		80	0	0	Sheep pasture .	32	0	0
		240				276	7	0

These calculations are proffered also for the encouragement of increased cultivation, founded on practical experience and observation; and with reference to the No. 4 system being so much the best, I have no doubt of the proportionally increased number of sheep, that it will keep in the flock, being also of at least 3*s.* per head improved value. No Down flockmaster can farm certainly well without sainfoin, it being a safeguard for winter provision and summer condition, taking also into consideration the often serious loss of other seed-plants, particularly clover, on light lands, which arises generally from its being sown too frequently, and from the previously exhausted state of the land. No seeds should consequently be sown either to mow or feed but in the first crop of corn manured for, and no red clover but once in eight years to mow, or any for feeding. One example of several that I have been employed in will serve to support my opinions on this subject; it consisted of 100 acres of old sown land.

Former State.				Improved State.			
Acres.	£.	s.	d.	Acres.	£.	s.	d.
25 Wheat . . .	0	0	0	25 Wheat . . .	0	0	0
25 Seeds . . .	62	10	0	25 Seeds . . .	62	10	0
25 Corn . . .	0	0	0	25 Corn . . .	0	0	0
25 Fallow for rape . .	62	10	0	25 Fallow . . .	62	10	0
25 Down pasture . .	12	10	0	25 Sainfoin . . .	62	10	0
Former produce .	137	10	0		£ 187	10	0
				Former state .	137	10	0
				Improved return	£ 50	0	0

This exhibits a benefit of 8*s.* per acre, independent of the rest given to the old sown land; and on this latter point I must remark, that any extraordinary crops I happened to grow were always to be attributed to the rest the land had, and not to extra cultivation or manuring; for example, 60 bushels of wheat per acre on land rested in lucerne, 54 bushels of wheat per acre after two years fallow, 52 ditto rested in sainfoin, 50 ditto from fresh broken down, and 10 and 12 quarters oats per acre rested in

sainfoin, these crops being grown on soil of that quality not to be rated at much more than half these returns on the average, without extraordinary farming. To these arguments for breaking up down may be added the further inducements in the commutation of tithes and the employment of labourers; and last, though not the least, the present facility for obtaining artificial manures at a very moderate price.

District No. 2

commences at New Shoreham, and is bounded southward by the sea and northward by the hills, beginning at Shoreham and passing in a line through Sompting, Patching, Arundel, Boxgrove, Chichester, Westborn, and Futington, &c., to Hampshire.

Soils.—This district may be called the garden of Sussex, the soil being mostly of good sound land, some small portion being adhesive on clay subsoil, and some portion on the higher parts flinty, and not so deep, but of similar quality. The meadow and pasture land is proportionally good in quality, but little of it is used for the purpose of sheep feeding on the stock system, being principally applied to the fattening of cattle and sheep.

Systems.—These are various and applicable to the soil, the adhesive land being alternately sown with wheat after tares, fallow, beans, seeds, and a few turnips. Part is farmed in fourths, viz.:

One-fourth wheat.	One-eighth oats.
One-fourth turnips.	One-eighth seed, peas, and beans.
One-fourth barley.	

Part used in sixths, viz.:

One-sixth turnips.	One-sixth wheat.
One-sixth barley.	One-sixth beans or peas.
One-sixth seeds to mow and feed.	One-sixth wheat.

And in this much recommended system (on good land) I observed that the seeds for feeding were trefoil and white clover together, with which ewes and lambs are kept and fatted.

In some parts where breeding flocks are kept, and there is a portion of down, or the greater proportion of the farm is of thinner soil, the four-course system with the alternate cropping is adopted.

Remarks.—I visited many parishes in this district for the commutation of tithes that were estimated at 40 bushels of wheat per acre and the other crops in proportion. A great number of sheep and lambs are fatted on the arable lands on turnips and seeds, &c., and also cattle and sheep on the pasture lands, as well as in stalls, on cake, linseed, &c., and on hay and roots, principally Swedish turnips, which contain so much nutritive quality, that on some farms neither corn nor oil-cake is given to sheep on

the land, nor to stall-fed cattle. I have no improvements to suggest in this district. The soil is good, well cultivated, and very productive.

District No. 3.

This district comprises all the remainder of the county lying northward of the two first described, and is commonly known as the Weald of Sussex.

Soils.—This extensive division of the county may be considered to contain a considerable portion of what is called cold clay, some part shravy land, flinty, and gravelly, on clay subsoil; sandy lands, both black and white; black lands, sandy and chalk loams, and a small portion of marly soil, with very extensive unproductive waste or common land, and also extensive marsh grazing lands. The greater portion of pasture is of that quality which is applied to the breeding and rearing of cattle and sheep, and for dairying and suckling, &c.

System.—The farming of the arable land is of course various, principally three and four-course, and in some of the most inferior lands five, six, seven, and eight-course, with some portion only occasionally cultivated.

Remarks.—The produce and management in this district are very inferior proportionably to the last quoted, it being occupied principally by tenants who are not men of sufficient capital to farm beneficially even for themselves. Many still continue to labour on as their grandfathers did in system, fearful that if they should put more capital in their farms by improvements the landlords would take the advantage of it and raise their rents. One custom has prevailed as long as I can remember, that of taking lambs to keep from the 29th of September to the 25th of March next ensuing, or to the 5th of April, being six months' keep, for which 6*s.* per head are commonly paid. Previous to Christmas they are kept in the stubbles and clover lays, with perhaps an occasional change to the meadow and pasture lands; the latter part of the season they must, of course, live on the hedges and hedge-rows, then to the meadow and pastures, and the young wheat (if any plant) for fear it would be too rank; if weak, then with the idea of improving the stock of it; and lastly altogether in the meadow and pasture fields, living principally, in a backward spring, *in* and *upon the hedges,* for I have seen them return home *with nearly all the wool off their necks to the shoulders,* and partially from the body. The keepers are bound to give them hay if they require it, but the chances are that, if offered, it would be of a quality they would not eat; and consequently they are sent back in a condition which accounts in some degree for the size of ewes in the down flocks, from which they had been taken in good condition.

Thousands are brought from Kent, principally out of Romney Marsh, for which sort 6*d.* and sometimes 1*s.* per head more is paid than for the Down lambs, with presents to those farmers who send them in the best condition to the place of meeting on the 5th of April—the condition, however, being worse from the size of the lambs of this breed, and the longer time of keeping. There appear to be two parties in error—those who put out their lambs in good condition to be thus treated, and also those who take them at a much greater loss, not having a blade of grass left on their lands for cattle of any sort of their own. I surveyed four parishes together about 2 years past of 28,000 acres where this system is adopted in full, about 20,000 acres of which are arable, meadow, and pasture. I found, from the best information I could obtain, when the winter-kept sheep were sent away there might be 200 or 300 others remaining, where thousands might be profitably and permanently kept, and with great benefit on the arable lands for a preparation for wheat. This is the case to a great extent in this district. I remember a very different system 50 years ago, when, with very few exceptions, this class of farmers used to wean and bring up Sussex-bred calves, and on the larger farms keep a sufficient number to do a portion of the work on them (now rarely to be found), and well supply the fairs in the neighbourhood with good well-bred oxen and steers of all ages, that were much in demand by the Down farmers, for working, and the old oxen of a superior quality for the Kentish hop-growers to fat and make their manures, and to this change may the altered character of the Sussex breed (now become so nearly extinct as to be worthy only to be exhibited as a cross-bred animal) be attributed. This is a most lamentable fact connected with the loss of manures and the description of cattle now substituted. It can only be recoverable by the employment of fresh capital, rendered necessary by the fall of prices in the last 30 years, and increased poor-rates from want of means to employ the labourers. Under these emergencies great numbers of farmers have sunk, and many are still feeling the effect of them. Some of the latter may be succeeded by the unincumbered capitalist, who can, at a fair rent, employ his capital to advantage (if he can have a lease) by adopting a course of farming applicable to the soil, and properly cultivating, manuring, and under-draining, if necessary; he can buy artificial manures at a cheap rate for money, and apply them to increase the produce of roots on the arable land for the winter maintenance of stock, and so make his manures of better quality and quantity. Compare the two farmers: the one using his arable land in a three-course system—wheat, oats, seeds, and too often a portion of peas and beans (not half cultivated), and the remainder naked fallow (the principal part of this portion to be limed,

and that in some situations at more expense for carriage than the cost price of the lime) ; this is the farming of many at the present time, some not having means of their own, and paying interest perhaps at 5 per cent. on the capital employed or part of it. The other farms, in a four-course system—1. wheat; 2. half red clover, half other seeds to mow or pasture as may be required, taking care that the part sown with red clover be dunged, which if so farmed on the most adhesive soils (even cold clay) would make more return in hay and seed than the wheat or any crop on the farm. Then 3. oats; 4. half may be part in tares to mow for the horses in the yard, only a sufficient part of peas or beans to fat the pigs for family consumption, only a part for potatoes for the family, and as much to the labourers on the farm as they may require; half being made clean summer fallow, being 1-8th, on which the red clover to be sown after wheat. I am confident, without further detail, that the difference of the produce of the last course would be remuneration for the capital, and payment of the same rent, &c.; whereas, in my opinion, the other would not. I have visited *some* parishes in this extensive district where the farming was principally three-course, where the average has been taken at 18 bushels of wheat and the oats at 20 bushels, and *a great many* where the average was taken at 20 bushels of wheat and oats at 24 bushels per acre, where I also found the system to be generally in thirds. My business was as local agent to the Tithe Commissioners, to ascertain whether the produce of the parishes I was sent to report on represented the value of the tithes proposed by land and tithe-owners for commutation, where I was, of course, supplied with a schedule of the quantities of arable, meadow, and pasture, &c., of every parish I visited. It is this survey which enables me to submit my statements with accuracy, but I am fearful, in treating the subject, of making it too voluminous.

My observation respecting the systems of farming must be taken to apply generally, where the lands require attention to support themselves in their produce—local neighbourhood to towns giving to farmers advantages of other resources which will enable them to adopt different courses, according to circumstances. I am very desirous in these critical times to sympathize and give encouragement to the tenant farmers, it being with many of them an almost heartless task; but Necessity compels them to continue, and those who are so circumstanced, let me invite to apply to that mother of invention to assist them in their pursuits; and should any benefit be derived from my experience, the object of my submitting it will be obtained.

One very formidable enemy to the dependent farmers exists in the competition for lands by persons sometimes scientific, who are

led to it by improvement of system and other advantages they calculate on in the present day. These facts are stated with an anxious wish to excite the present tenants to exert themselves in retaining their occupations by adopting themselves the benefits contemplated by these competitors, and so supersede them by themselves increasing the produce of their lands. Landlords can, in many parishes of this district, assist the tenants by permitting the cultivation of the inferior pasture lands, of which thousands of acres are now almost unproductive, and could be cultivated at little or no increased expense to the occupiers. This would benefit the tenant farmer and improve the estate, and be the best, or I may say, the only resource in the present prospective difficulty.

Supposed present Produce.

Acres.		£.	s.	d.
10	wheat, 20 bushels per acre, 7*s.* per bushel	70	0	0
10	oats, 24 bushels per acre, 2*s.* 9*d.* per bushel	33	0	0
4	seed, 40*s.* per acre	8	0	0
3	tares and potatoes, 50*s.* per acre	7	10	0
3	fallow	0	0	0
30				
10	inferior pasture	10	0	0
40		£128	10	0

Increased produce by improved management at same prices.

Acres.		£.	s.	d.
10	wheat, 28 bushels per acre, 7*s.* per bushel	98	0	0
10	seeds to mow and feed, 50*s.* per acre	25	0	0
10	oats, 33 bushels per acre, 2*s.* 9*d.* per bushel	45	7	6
5	tares and potatoes, &c., 50*s.* per acre	12	10	0
5	fallow	0	0	0
40		180	17	6
	Improved value at same prices	52	7	6
		£128	10	0

Increased produce by same improved system at probable low prices.

Acres.		£.	s.	d.
10	wheat, 28 bushels per acre, 5*s.* per bushel	70	0	0
10	seeds, 50*s.* per acre	25	0	0
10	oats, 33 bushels, 2*s.* per bushel	33	0	0
5	tares, &c., 50*s.* per acre	12	10	0
5	fallow	0	0	0
40		140	10	0
	Improved value at probable low prices	12	0	0
		£128	10	0

My object in these tables is to benefit particularly that class of tenants (and they are the majority) who have no other resources

for their support but what their occupations return them for their capital employed. I by no means intend to imply that there is no good farming in Sussex; there is a great deal, and many independent farmers too, and much improvement going on in all parts of the county; and these are now the only parties who are likely to make farming answer: as, having resources in the time of need, they are not compelled to sell their cattle half-fattened, nor take their corn to over supplied markets. In the north-eastern extremity of this district are to be found well-cultivated hop lands, which would be profitable but for the extensive competition of inferior and unkind plantations, which are injurious to the general growers, and too often rob the whole farm of the manures and attention it would otherwise have; but as there is no Act of Parliament to prevent men from being speculative, so must the consequences of over plantation of hops produce low and unprofitable prices on the unkind lands, and prove, consequently, injurious to the whole of the growers. This is the evil, and not the duty so much complained of—nay, I am of opinion that, if dispensed with, it would encourage more plantations and increase the evil; for hops are not to be compared to the growth of corn, for which there must be a demand at some price; but an over plantation of hops (an article not consumable even by pigs) must be an error. The sacrifice is apparently great in capital to give up the unprofitable gardens, but had better be at once adopted. The same advice cannot be given as in the case of corn, to reduce the quantity of acres—increasing the produce of the remainder by better cultivation and manuring; this would not meet the general difficulty, nor answer the general purpose of the occupiers: it is impossible that 8 cwt. per acre can compete against 20. But that increased supply beyond the demand affects the prices, to render it unprofitable to the one and injurious to the other.

Improvements.—The further proposed improvements of importance consist in the diminution of fences in the enclosed lands of this district, and taking out of such as necessarily remain all timber and trees whatsoever, which are very injurious to the land and unprofitable to the owner; for, being exposed to the winds, they make no growth, and if permitted to stand for a century would only then make a few posts and rails, of a few shillings' value, doing, meanwhile, as many pounds damage in destroying the live fence under them and the produce about them. Fences can only be necessary to the depastured fields and for outside protection; when any portion of the arable land is depastured, temporary fences of hurdles, wattles, net or wire, &c., according to circumstances, are more desirable, the fences not being commonly in the situation to be useful, and, when they are, the fences themselves require the protection of hurdles against sheep feeding by them.

When the ditches were made in wet land with these fences, it supposed, no doubt, a benefit to the drainage; but where little advantage is taken for this purpose, a proper under drain would be more beneficial.

Extirpation of Charlock.—The only way is by constantly pulling it; the expense is considerable at first, but by perseverance becomes trifling. In the neighbourhood of Brighton I have seen land in the occupation of Mr. C. Beard, so nearly cleared by this mode, that the cost of cleaning all that was visible on 80 acres of barley together would not be more than 20*s.*, and this was on light chalk soil. The management of this land was principally rape, for sheep-feeding (the charlock pulled out of it), next wheat, carefully looked over, the charlock pulled out, and also from the barley (which is sown with seeds), generally for two years' pasture. I am of opinion that a clean winter and summer fallow would weaken it very much; I observed this from experience, but as the land on the downs is generally wanted for feed of some sort, this can be but very little done. I have seen the rape drilled and horse-hoed to some advantage. Then the charlock in the rows only requires pulling; this is attended with less expense, but is not so effectual. I have observed that where the land is turniped, it is much cleaner of this nuisance by means of the hoeing. I visited a great many parishes in Hampshire for tithe, and the general system there practised of turnips, barley, seeds, &c., for wheat makes their land certainly cleaner altogether than in Sussex. But the turnip system on the downs not being adapted, for the reasons before stated, of the unkindness for wheat, &c., compels them to do the best they can by feeding it before it seeds, and by previously growing it out before the rape is sown. For if all were inclined to do it effectually by pulling, they could not for want of hands. This I advance from experience in the parish I farmed in many years; and consequently when it gets ripe in the rape, the sheep not liking it, disperse it on the land when feeding the rape.

Improvement of Dwellings and Condition of the Farm Labourer.—I do not think much complaint can be made of the labourers' dwellings in the county: they are of course airy, and in some instances rather too much so, where the repairs are not properly kept up. In the villages they are generally cleanly, and accommodated with some proportion of garden ground; much improvement may be made in this department, very few, comparatively, taking any pains about the produce which might be raised by cultivation and manuring: much benefit may be obtained from a small piece of land if properly attended to. In every parish I would recommend premiums to be given to the best cultivated garden or gardens, and also for the best vegetables; the mode of culti-

vation and manuring being always certified with the articles exhibited.

The next thing that affords great assistance and comfort, and is worthy of all classes to join them, is a sick-club society; this affords them an independent resource in time of need. Those founded on the annual dissolution plan are the best—returning them once a year the unrequired amount monthly subscribed. I belonged to one of this description for many years, paying 2*s.* 3*d.* per month for 12 months; the members received back, on the average, more than one-half the amount paid: the sick receiving for the first 6 months, 10*s.* per week; the remaining six months, 5*s.* per week; and afterwards a pension of two shillings per week. This was not in a populous neighbourhood, but consisted of 170 members when I left in 1835, and continues now about the same number. On the decease of a member 1*s.* each to be paid by the members at the next monthly meeting, and given to the friends of the deceased. I introduced also, in the same parish of Rottingdean in the year 1835, a medical club, which has now between 200 and 300 members. The single man pays 1*d.* per week by the quarter; a man and his wife 7*s.* 8*d.* per annum, quarterly; a man, wife, and two children, 12*s.* 4*d.* per annum; a man, wife, and four children, 15*s.* per annum, being 1*s.* 7*d.* per head only for the children; and this includes all cases requiring the attendance of a medical man and medicine, except midwifery cases, for which the extra charge is 10*s.* And it appears from this statement that a man, his wife, and four children, by belonging to the medical club, are certainly provided for, as before stated, for the trifling sum of 6½*d.* per week for 52 weeks, 2*s.* 4*d.* per month for 12 months, and 1*l.* 8*s.* for the year.

To conclude: I will briefly sum up the improvements that have taken place in the county of Sussex from 1808 to 1849. Draining, under-draining, the use of artificial manures at reduced prices, increased cultivation, increased produce of roots and other green crops, better management of sheep and cattle, improved machinery and agricultural implements, increased consumption by visitors at watering-places, Tithe Commutation, and lastly the Poor Law Amendment Act, which has removed a great burthen from the land, Sussex having been, previously to the improvement in the poor-laws, one of the highest counties for poor-rates and also for wages. The various external causes which during the same period have lowered from time to time the price of corn, the nature of this publication will not allow me to dwell upon. These changes brought almost instant ruin to some; others were obliged to have recourse for a time to their property; and some, by the partial exhaustion of their capital in stock, &c., were formerly or now are reduced to that state that they are

unable to take advantage of the improvements that are continually brought forward.

Under these trying circumstances I can here only reiterate the advice I have previously given to farmers—to study and apply the system of farming best calculated for their respective soils, and to increase their quantity of arable land by bringing into cultivation any inferior pasture that they may have, and I believe that the adoption of these measures would afford them some relief in their present and prospective state. And here, with my best wishes for the prosperity of the agriculturist, I take my leave of the subject.

V.—*On Winter Feeding of Sheep.* By Captain the Hon. Dudley Pelham, R.N., M.P.

To Mr. Pusey.

My dear Pusey,—Having for four years been paying some attention to the practice of home or shed-feeding of sheep, I am disposed to think it is a subject which has not yet been sufficiently considered by farmers, and that benefit may result from their attention being drawn to the practice, and I address you in the hope you may consider my remarks worthy of a place in the Royal Agricultural Journal. Most people have long given up, as erroneous in principle and unprofitable in practice, the *winter* grazing, or attempting to *fatten,* oxen in the field,—exposed to wet and cold, and injuriously *poaching* the land,—at that season; and it has become a general method to bring turnips to the homestead to feed store oxen in addition to their consumption of straw in their mere manure-making occupation, as well as for the purpose of *fattening* in enclosed buildings those animals, whether oxen or pigs, intended for immediate sale to the butcher; but when such a proposition is made as bringing in turnips to be consumed by sheep in sheds at the homestead, or on particular spots on the farm, if a large one, most men are startled at, and immediately condemn, the supposed extravagance of carting in the sheep's food, and carting out the sheep's manure; probably because it is considered that the commoner mode of taking the sheep to the turnips is the simplest way of manuring the land; nevertheless, I venture to believe that shed-feeding will by-and-by become more general for the winter-grazing or fattening sheep.

I am not going to trench upon the ground so well occupied by Mr. Lawes, in his late paper on sheep-feeding, but shall confine myself to inviting the comparison between field-feeding and shed-feeding sheep for the butcher in the winter or colder and wetter

months of the year. I have doubts whether in general the shed-feeding sheep in summer will prove the best. I believe to Sir Richard Simeon, who for some years has fattened a large number of sheep *throughout the year* in stalls, is due the merit of having first adopted this practice as a system, and on a large scale. The late Lords Talbot and Yarborough, and a few other gentlemen, followed Sir R. Simeon's example to a certain extent, but general attention has not been drawn to the practice, and it appears to have been so little considered in all its bearings, judging partly from remarks of many who have visited my sheep-sheds, that I venture, though with diffidence, to address you on the subject.

Careful experiments that I made led me to the conclusion, urged upon me by Mr. Huxtable, that I was wrong in using Sir R. Simeon's method of stalling or tying-up each sheep, and that they fatten quicker when loose, in pens of half a dozen; and if so, there is economy in carpenter's work and materials in fitting-up the shed, whilst less time is occupied in feeding the sheep than with the stalling plan; and, therefore, although I still use both methods, because it has not been convenient hitherto to alter the arrangement in my first sheep-house, I much prefer penning to stalling the sheep; and the butchers invariably select the loose sheep first (for I usually sell at home); and another advantage in the loose system is, that the sheep will be found more fit to travel to market than stalled sheep, which often require to be removed out of their stalls a few days previous to sending to market, unless they are conveyed there on wheels.

I will now endeavour to convey to you my notion of the more general application of this system of feeding, and then to describe what I conceive to be as economical and useful a building (beyond a mere make-shift) for the purpose, on the majority of farms, as I can suggest. Given a crop of turnips, the question to be determined is, the most profitable method of consuming it with sheep in the winter months, assuming that the owner of the crop desires not only to maintain a certain quantity of store sheep, or his breeding flock, but also to fatten off wethers or draft ewes. If the land is strong, it will be injured by much treading in wet weather, and the sheep will then thrive little, barely, if at all, *maintaining* their condition for weeks together. If the land is light, it may no doubt be benefited by treading; still here, the sheep will at times not *fatten*, exposed to cold and wet, and great is the expenditure of extra or artificial food, improving in some degree the land perhaps, but not *fattening* the sheep, or very slowly; meanwhile the consumption of the turnip-crop is rapidly proceeding, the interest of one's money long dormant, and the benefit the land is to derive from the manure dropped daily upon it is very greatly neutralized by evaporation and the washing away of a

great portion of it from the surface of the land in heavy rains; it is only in favourable weather, and upon the lighter soils, that the plough can follow closely upon the sheep and bury the manure, and considerable time will elapse after the earliest turnips are fed off before the following crop is sown; besides, the sheep frequently catch colds and epidemics, and become diseased in the feet, and then one is disappointed in the sale, both as to time and weight. Now what I wish to throw out for consideration as a somewhat general practice is this, whether it be not preferable in winter to *confine the field-feeding* of sheep to the mere maintenance of the store-sheep or breeding-flock, and to conduct the *fattening* of those sheep destined immediately for the butcher in sheds. In the latter case, properly attended to, they are in no way retarded in their progress by the weather, are constantly *dry* and healthy, fatten more quickly, consume much less food in proportion to their progress,—the animal heat being kept up by shelter and warmth, instead of at the expense of food,—the money is turned much quicker, the manure is so much richer and so much more effective, that, applied as it should be to the land just previous to sowing the following crop, it is more efficacious, or a smaller quantity suffices; and, lastly, there is no *waste of food.* All these advantages are to be weighed in the balance mainly with the labour and expense of carting in turnips and carting out the manure, and the expense of buildings.

It must of course in this, as in other methods of conducting farm operations, be a matter for consideration with a farmer whether the circumstances under which he is farming (whether in relation to the quantity or extent of his land, the labour of carting, either in respect to level, or distance from the homestead or field-shed, or as to his general management) are such as to render it worth his while to make the experiment in question; but assuming either that he can satisfactorily erect, upon a large farm, suitable sheds at certain points, to which the haulage from several fields, and back again, might be satisfactorily accomplished as the successive turnip-crops were applicable, or that the distance to and from the homestead be not too great, I submit that the subject is worth the attention of farmers, and, the above circumstances being *favourable,* I would suggest the following arrangement —carrying from the field to the shed half or a portion of the turnips for the fattening sheep; and I believe that in this manner a greater number of fat sheep may be turned off the farm with the same quantity of roots now grown, whilst a larger number of store-sheep or a larger flock may be maintained in the field if desirable, less of the crop being required for the fattening sheep. My own practice is to fatten out one lot of sheep in the winter thus:—to take the manure made in the shed and mix it with ashes under an

adjoining open shed, where it will dry readily; and either to lay it on the land just before the last ploughing for the barley crop, or to drill it in with the turnip-seed. It may be a further question, whether, particularly on the stronger lands, the young growing store-sheep should be kept in the field or in the homestead at certain periods, with open sheds and yards to run in; but with regard to *winter-fattening* of sheep, if it is to be done at all as a mode of profitable consumption of turnips, I incline to the opinion that the shed-feeding system under certain, and not uncommon, circumstances is likely to be more extensively practised as the right system. I find that after the severe weather sets in, the butchers are glad enough to come in search of house-fed sheep, not being able then to find in one's neighbours' fields as many sheep fit for their selection as they require. I think the following mode of constructing a shed will answer two useful purposes at no great expense; adapting it for fattening out in the early part of winter, in one lot, a number of sheep, and then serving as a permanent *lambing-shed*. To be constructed, say, of larch uprights, sawn down the middle with the bark outwards, or, if peeled, to have a coating of *vegetable* tar or rough paint, with a span roof, thatched or *space*-slated, thus increasing ventilation and saving one-third in the quantity of slates, and reducing proportionably the weight upon and necessary strength of the roofing; a height of 4 feet to the *plate* will suffice; a paved walk down the middle of the shed, the troughs being placed on either side, and next to the passage, for convenience in feeding and cleaning; each side to be divided into pens with poles or rough fencing; the gates by which the sheep enter the pens being so arranged, that, when the shed is required for lambing, the whole width shall be available by the gates folding across the pathway (in the manner railway gates are fitted across a line), and the south side or elevation of the shed (if not both sides) being fitted so that the wood-work can be folded back, or be lifted up, for the general convenience of the shepherd, and the admission of the sun and air, and for the more easy emptying it of the manure; the several partitions of the shed being further subdivided by the shepherd for his ewes and lambs, as he may desire, with hurdles. The sheep to be upon *gratings*, made with oak frames and deal tops $\frac{3}{4}$ of an inch between the bars, requiring no litter excepting for lambing; beneath the gratings, which should be supported on either side,—without cross supports, which are inconvenient in emptying the pit,—should be a tank or pit in brick-work, or rammed with marl, not less than $2\frac{1}{2}$ to 3 feet deep, so as to contain all the manure dropped by one lot of fatting sheep, thus avoiding the necessity of disturbing the animals for the removal of the manure. If a little gypsum is thrown over the gratings, and ven-

tilation is freely given, the sheds will not have an offensive smell; sheep-sheds, I have found, should not be so warm as ox-sheds. Mine are so contrived that an *even* temperature can be readily kept up of about 50° in the latter and 45° in the former. Pens measuring 8 feet by 6 will be found a convenient size for six Down sheep, thus giving 6 feet in width to each pen, and 3 feet for the walk down the middle; the shed will require to be 15 feet wide, the length being determined by the number to be provided for. A rough shed may easily be constructed for experiments, but it may be worth while, when erecting a permanent building as described, to add a similar or an ordinary shed as a wing on either side, which may be used for a variety of purposes, thus enclosing and sheltering the lambing-yard on three sides.

The expense of attendance is trifling, if boys are principally employed, little exceeding what is required in the field; and the cartage of turnips not so serious; about 2 tons per week, in addition to other food, will be consumed by 50 Down sheep. The average time required to fat sheep in this way is about twelve weeks. I do not enter upon the subject of feeding in detail, because much has been written upon it, nor do I pretend to have satisfied myself whether I use the best proportions or kind of food; and the object of these remarks is a mere *comparison as to feeding in winter in or out of doors.* I doubt whether, as a general result, an increase of weight exceeding 2 to 2½ lbs. per week per 100 lbs. live weight should be reckoned upon, although there are much higher statements made upon this point.

I have had a sheep increase for three weeks at the rate of 4½ lbs, but it will sometimes be found that a sheep will not increase at all, whether in or out of the shed, for weeks, and for obvious reasons one must not expect general results to be as favourable as those of particular experiments. Fixed sheds, suitable for thus feeding sheep, need not necessarily be expensively constructed; I have never yet met with a good plan for thoroughly sheltering sheep in the field, combining what we require, cheapness and portability. I conceive long-woolled sheep would fatten in sheds equally as well as the short-woolled, if not kept in so warm a temperature. For winter feeding, when the sheep have turnips, there is no need for the expensive arrangements for laying on water in the sheds that are sometimes to be seen; and I do not think much objection need be urged to the plan of shed-feeding sheep in respect to expense, if the buildings are constructed as I have described, and are made to answer other purposes—a great desideratum in farm-buildings. I have tried placing the sheep on a brick-floor with an incline to a tank, littered with chaff, but they were too wet, and the consumption of litter was too great; I therefore prefer the gratings, which will wear a long time: there

is, however, economy of litter in lambing under a shed of this kind, from the moisture so readily escaping from the straw through the gratings; none is necessary for the fattening sheep. I cannot speak confidently on the point, but experiments I have had made give a weight of more than 2 cwt. of excellent pungent manure—weighed before it has dried thoroughly—from each sheep in twelve weeks; this applied directly to a young crop is very valuable, whatever the amount may be.

I beg to repeat, that the general arrangement of this mode of sheep-feeding has been derived from that of Sir R. Simeon, from whom I have received much kind information; the penning the sheep loose is the result of careful experiments I made at Mr. Huxtable's suggestion, whilst the plan of adapting the shed to lambing and other purposes is a notion of mine for the sake of convenience and economy; and that my object in addressing you is the hope of usefully inviting investigation of a practice on which I have had frequent inquiries to answer, but which has not been as fully and fairly considered as I think it may be with advantage to the agricultural community.

I will just add, that an easy way of trying the experiment is to have the gratings raised on *feet*, so as to be available in any spare or rough shed for a time, or in a barn; if a pit should ultimately be determined upon, the gratings will be available on removing the feet.

Believe me to be yours very faithfully,
DUDLEY PELHAM.

St. Lawrence, Isle of Wight,
Jan. 15, 1850.

VI.—*The Improvement of Land by Warping, Chemically considered.* By THORNTON J. HERAPATH.

IN many of the counties of England and Scotland, more particularly in those of Lincoln and York, there are certain districts, bordering upon the larger rivers and their tributaries, where the agriculturists are in the habit of manuring their land or of restoring its exhausted fertility by means of a peculiar mode of irrigation, which is there termed "*warping.*" In order that this operation should be pursued with advantage, two points are necessary: namely, first, that the general level of the country through which the river flows, should be below that of high tide; and, second, that the water of the river should be of a very muddy character, as the main object of the farmer consists in producing an equal and uniform distribution of the alluvial matters, which are kept in suspension by the water, over the surface of the land.

For this purpose, the river-water, at low tide, is allowed to flood the land intended to be so warped by means of outlets in the banks of the river, and prepared channels and sluices, and it is then kept there until it has deposited the mud or silt with which it is charged. When this has taken place, the clear water is permitted to flow off by other channels and return to the river. Fresh quantities of water are then again admitted at every succeeding tide, each of which produces a new superstratum of sedimentary matter, and this operation is repeated until the requisite thickness of warp has been obtained. The quantity of warp so deposited by each successive tide in many cases exceeds one-tenth of an inch in thickness; it varies, however, greatly at different periods of the year, according as there is much or little fresh-water in the river and in the position of the land. By these means, then, there is created in the course of a few months a new soil of considerable depth, which consists, for the most part, of the various kinds of earth and undecomposed vegetable and animal matters which the waters of the river have collected and borne along in their course. Land so warped is said to possess a natural power of production of the most remarkable kind, and a degree of fertility far exceeding that which is produced by any of the ordinary processes of cultivation. In fact, vast tracts of perfectly sterile sandy and peaty soils in the neighbourhood of the rivers Humber, Trent, and Ouse are yearly converted into good arable land solely by the agency of this operation.

Although this process of warping has been only known in England for rather more than one hundred years, having been first practised near Howden, on the banks of the Humber, about the middle of the last century, and brought prominently before the public by Mr. Marshall in 1788, it has been long followed on the Continent, under a different name, with great success, and is thus described by Mr. Cadell, in his 'Journey in Carniola:'—

"In the Val di Chiana, fields that are too low are raised and fertilized by the process called *colmata*, which is done in the following manner:—The field is surrounded by an embankment to confine the water; the dyke of the rivulet is broken down so as to admit the muddy waters of the high floods. The Chiana itself is too powerful a body of water for this purpose, it is only the streams that flow into the Chiana that are used. This water is allowed to deposit its mud upon the field. The water is then let off into the river at the lower end of the field by a discharging source called *scola*, and in French *canal d'écoulement*. The water-course which conducts the water from a river, either to a field for irrigation or a mill, is called *gora*. In this manner a field will be raised five and a half and sometimes seven and a half feet in ten years. If the dyke is broken down to the bottom, the field will be raised to the same height in seven years: but then in this case gravel is also carried in along with the mud. In a field of twenty-five acres, which had been six years under the process of *colmata*, in which the dyke was broken down to within three feet of the

bottom, the process was seen to be so far advanced, that only another year was requisite for its completion. The flood in this instance had been much charged with soil. The water which comes off cultivated land completes the process sooner than that which comes off hill and woodland. Almost the whole of the *Val di Chiana* has been raised by the process of *colmata*."

Whoever will take the trouble to examine a map of England, will readily perceive that the peculiar situation of the counties of York and Lincoln with respect to the sea offers considerable advantages for the prosecution of this operation. Not only are they both more than half surrounded by water, but the greater portion also of the country so situated lies considerably below the level of the sea; from the encroachment of which, indeed, it is only preserved by extensive walls and embankments, which have been erected and maintained at a great expense. The water of the rivers that flow through such a district, as may be naturally supposed, is highly charged with a fine mud, admirably adapted for the purposes of the warper, who conducts his operations as follows: An excavation having been made in the river-bank, under the bed of the stream, a *clough* is built, which directly communicates with a main drain or duct, often of large size and several feet in width. This drain is furnished with substantially-built raised embankments of very solid earth, and is formed for the purpose of conveying the muddy water from the river to the land intended to be warped, over which it is gradually and equally distributed by numerous smaller lateral drains; the said land having been previously laid as nearly upon a level as circumstances will admit of. In order to confine the water to this particular spot, and prevent it from overflowing the adjacent country, the land is surrounded and divided into compartments of about 20 acres in extent by strong well-formed banks, which are of the same height as those of the main feeder, but neither so wide nor solid. Then again there is an inner bank all round, which has openings in it adjacent to the lowermost parts of the land for the purpose of getting the muddy water to those places as soon as possible. In this way each flood-tide is conducted into every one of the compartments in succession; and, as it ebbs, the hydrostatic pressure of the water alone suffices to force open the swinging doors of the return sluices, thus allowing itself to escape into the main canal, and thence into the river, after having deposited nearly the whole of its mud upon the surface of the enclosed land. Of course, the higher the tides are, the greater is the depth of water to produce the deposit, and *vice versâ*. Considerable skill is required to be exercised in adjusting the size of the cloughs, so as to discharge the whole of the water before the rise of the next tide, as otherwise only every other tide can be admitted.

By the above plan, however, it has been found possible to warp land in one year to the depth of from 2 to 3 feet, and this is generally considered to be quite deep enough and is permanent in its action. This statement, of course, only applies to those lands which are sufficiently below high-water mark; where the level is higher, a longer time, often from 2 to 3 and sometimes even 4 years, is required.

In the year 1825 the Society of Arts voted a premium, consisting of its large gold medal, to Mr. Ralph Creyke, jun., for his description of the process of warping, by an improved method, a tract of 429 acres of peat-moss. The particulars of this stupendous undertaking are thus detailed in the following extracts from that gentleman's letter to Mr. Aikin, the Secretary of the Society:—

"In the neighbourhood of Rawcliffe House, where I reside, are many thousand acres of peat moss and waste land, which yield scarcely any annual rent, and which I thought (from the experience I had got in improving a considerable quantity of my own land near home) might be improved very much by being warped. I accordingly undertook to warp from the river Ouse 1600 acres; and in August, 1821, a sluice, with two openings of 16 feet each, and 19 feet high from the sole to the crown of the arch, with substantial folding-doors, was built and opened; and at the same time a main drain was cut, extending from it two miles and a half, up to the waste land and peat moss: its dimensions were 30 feet wide at the bottom and 90 feet wide at the surface of the land, and the banks were raised upon the land to the height of ten feet. In the river Ouse, at the point where the sluice is erected, the tides flow to their height in three hours, and ebb nine hours. The height is from 14 to 18 feet." * * * "The sluice was built of stone of large size, backed with brick; the foundation was well piled with 550 piles, 13 feet long, squaring 11 inches, upon which were firmly secured very strong beams; upon the beams the whole space upon which the sluice was built was planked with four-inch deals, another set of beams were placed crossways, and then a second floor of three-inch plank. Sleeting piles were driven the whole length of the woodwork, both fronting the river and next the main drain; a wall was also erected from the sluice to the river, to protect the bank from being injured." * * * "The length of the embankment," he goes on to say, "to retain the tide-water, must depend upon the quantity of land embanked; these banks must be well puddled, and made with the greatest care. The dimensions of our banks are 32 feet at the base, 10 feet high, and 6 feet wide at the top. The cost of them, 3*s*. per floor of 20 poles."

The operation was commenced in the latter part of the year 1821, and in the following season 429 out of the 1600 acres were covered with a deposited soil to the depth of 3 feet. In 1823, this land was sown with oats and grass-seeds, and on the fourth year bore an excellent crop of wheat. By this time, the other two compartments, respectively consisting of 500 and 671 acres, were completed and in a state of preparation for their first crop of oats, &c. In this case, so great was the improvement, that land, which before warping was entirely unproductive and yielded

no rent whatever, in the course of four years produced abundant crops and readily let for 35*s*. per acre.

In carrying out the above magnificent operations, however, Mr. Creyke required the assistance of considerable capital, as the outlay greatly exceeded 17,000*l*.—viz. for the sluice and its appendages, 5500*l*.; for the main drain and embankments, 7350*l*.; and 4682*l*. more for land, &c.; besides this a very considerable expense was annually incurred in repairing the main drain, more particularly that part of it near the sluice, and a loss of more than 1000*l*. was also experienced in the first year in consequence of an accident which occurred to the embankments.

According to Mr. Creyke, the great superiority of his process over those ordinarily followed—

"consists in creating a fine, deep, rich soil, more effectually, upon a larger scale and in a shorter time than has hitherto been practised. According to the usual practice, the tides are only admitted during the months of August, September, and October; in mine they are admitted all the year round. The sluice was not more than 5 feet wide; mine has two openings of 16 feet wide. The main drain was only 12 feet wide; mine is 90 feet wide. Not more than 14 acres are embanked in one piece; I have enclosed 500 acres in one compartment. Formerly not more than 1½ foot of deposit was obtained; I have got from 3 to 5 feet upon the increased quantity of land. No levels used to be taken for the formation of the banks; the whole of my embankments have been laid out by the spirit-level. Scarcely any inlets used to be made for the purpose of spreading the tide-water quicker and more equally over the surface of the land, within the embankment, as well as for a more speedy return of it upon the ebb; in all my practice innumerable inlets are formed for this purpose."

In some cases parties have found it advisable to keep the water upon the land for twenty-four hours before it is allowed to return to the river, instead of permitting it to flow off at the receding of the tide, as is generally done. By so doing, it is said, they not only obtain an increased quantity of warp, but it is also much better in quality than that obtained by the usual method.

Experience has shown that the part of the field most distant from the warping-drain receives better warp, and is longer in attaining the desired elevation, than that part which is situated nearest the end of the drain. This is evidently occasioned by the heavier sandy portion of the mud settling first from the water, leaving the lighter earthy and organic particles still in suspension, which are thus carried on to the further part of the land.

There have been instances, it has been already said, where from one to two years only have been required for the completion of warping a piece of land well; but these are the exceptions rather than the rule: three years' tides are generally required, and in some cases even four years' tides are wanted. These differences, however, are of course in a great measure occasioned by the peculiar situation of the land. Thus, lands remote from the

banks of the river require a longer period of time than those situated nearer, and *vice versâ.* Some parties are in the habit of warping all the year round, except when prevented by frost; the best season of the year, however, for pursuing this operation is from March to October. The spring-tides about the equinox are generally considered to be the best tides for propelling warp; great care, however, should be taken not to admit any tides when it blows strong, or when the water of the river is much affected by land-floods in very rainy weather, as in either case considerable injury is apt to be sustained by the banks, and the muddy particles themselves do not deposit readily, on account of the agitated state of the water. It is in consequence of this and the rapid flow of the water that so much damage is frequently done in the winter season to the interior drainage of other lands in the same neighbourhood, which may not be under the process of warping at the time. To avoid this, certain parishes provide, that all warping drains shall be closed from October to March.

In fact, it is extremely necessary to keep warped land thoroughly drained, and it is principally on this account that peat-moor soil has been found to be the best natural soil to warp upon, as this species of land remains in a more loose and porous state under the deposit than others do. Peat-moss, nevertheless, is found to settle a great deal under the treatment, and the level of land thus warped is often found to become considerably lower than it was before the operation. As an instance of this, there are certain fields in the neighbourhood of Goole, Yorkshire, which are now settling in this way, and the proprietor is about to have the process repeated, in order to raise the level to its original height, for the purpose of keeping up the advantage of drainage, &c. There is no objection whatever to a great thickness of warp, provided good drainage is maintained.

Sandy soil is not so well adapted for warping in these respects as peat; the weight of the deposit coming upon the sand compresses it, so that the drainage is not so good. It is a well-established fact that the best crops, both as regards quality and quantity, are grown upon peat-moor soil.

Land which has been once well warped, it is said, does not require to be so treated a second time, as far as experience has proved.

The cost of so manuring a piece of land in an efficient manner varies from 13*l.* to 20*l.* per acre,* including labour. This difference, it need hardly be said, is in a great measure caused by the distance of the field from the river; the length, breadth, and

* According to Mr. Creyke ('Trans. Soc. Arts,' 1825, vol. xliii. p. 6) it amounts to 21*l.* per acre.

depth of the warping-drain will of course vary according to the situation of the land, consequently the expense of cutting, &c., must also vary in proportion.

The thickness of the deposit usually left upon the land, for those districts in the neighbourhood of the Trent, averages about 18 inches; the minimum being 6 inches, and the maximum 2 feet 6 inches, or 3 feet. In some few instances, it is true, it has been observed to reach as high as 4 or even 5 feet; but these occur only rarely, and in very good seasons. On lands in the parishes of Crosby and Scunthorpe, which stand upon a somewhat higher level than others in the immediate vicinity, the warp very seldom exceeds 6 inches in depth. It is never desirable, however, to be contented with less than 18 inches, when as much or more can be obtained. With regard to the qualities of warped land for the purposes of the agriculturist, it has been observed, that it is always best to allow land so treated to remain untouched for one year, in order to afford time for the atmospheric air to act upon the alluvial matters and reduce them to a proper temper (if it may be so called) and state of dryness. It is then sown down with four bushels of oats per acre and a mixture of clover and grass seeds. The crops so produced are then depastured by sheep for two years in succession, when the soil is ploughed up and planted with wheat and oats.

Beans and rape also thrive well upon this land; the former have even been found to succeed as a first crop. Barley and turnips, however, do not answer so well, on account of its slimy nature. Warped land is grateful for manure, but does not require any until it has been cropped a few times, say for five or six years. Guano is then found to be one of the best that answers. Linseed-cake and rich farm-yard manure also furnish very good results. Experience has proved, however, that the quality of the warp often makes considerable difference in this respect; so much so, in fact, that one-half of a field has done better without additional manure than the other half has with.

Having thus in the preceding pages given a brief account of everything that is known or has been written upon the subject of warping up to the present time, I shall now proceed to attempt to explain the *rationale* of the process, based upon chemical principles. Prior to doing so, however, it will be necessary for me to give an account of my analyses, from the consideration of which my conclusions have been arrived at.*

* Amongst the works to which I have referred for the practical details of the process, may be mentioned Mr. Creyke's Memoir, published in the forty-third volume of the Society for the Encouragement of Art, &c.; and an article in the 'Penny Magazine' for the year 1844. I have also derived several new facts from the notes which Mr. Kirkhy, the steward of R. Thorold, Esq., of Great Grimsby, kindly placed at my disposal.

With regard to the processes of analysis pursued in this investigation, all that need be said is, that they differed only in a few minor particulars from those ordinarily followed. I must, therefore, beg leave to refer all my readers who may wish for further information to Parnell's 'Elements of Chemical Analysis,' and Prof. Johnson's 'Lectures on Agricultural Chemistry and Geology,' in which works they will find everything they require.

To avoid confusion, it will be observed, that I have classified the results under four distinct heads, *i. e.*, A, which contains those of my analyses of the water of the river Trent, taken during the warping season; B, those of the warp from various localities; C, those of the different varieties of soil; and lastly, D, which includes those of the different crops grown upon natural and warped land.

A. *Analysis of the Warping Waters.*

I.—The first specimen examined was labelled "Water taken from the warping drain before going on the land; but owing to the continued rain, there was much fresh water in the River Trent, and the warp in consequence was not of an average quality."

Specific gravity of the filtered water at 58° Fahren. was 1·00033.

Composition of the water per gallon in its original state:—

Soluble salts:— 9·018	Chloride of calcium	traces
	Chloride of magnesium	0·592
	Chloride of sodium	3·760
	Chloride of potassium	0·096
	Nitrate of magnesia or lime	traces
	Crenate and apocrenate of magnesia or lime	1·840
	Organic extractive matter	0·202
	Sulphate of magnesia	0·848
	Sulphate of soda	1·680
Insoluble salts:— 16·880	Carbonate of lime	8·240
	Carbonate of magnesia	1·840
	Sulphate of lime	0·304
	Peroxide of iron*	1·728
	Alumina*	1·328
	Perphosphate of iron*	very minute traces
	Organic matters	0·320
	Silicic acid*	1·200
	Sand (exceedingly fine)*	1·920
		25·898

Insoluble warp, separable by filter, 233·380.

* Those substances which are thus marked in this and the following analysis doubtless existed in mechanical suspension in the water, although they were in a state of too minute division to be stopped by a filter of white bibulous paper.

II.—This specimen was labelled "Water taken from the warping drain at the ebb of the tide, whilst flowing off the land." Specific gravity of the filtered water at 59½° Fahren. was 1·00034.

Composition of the water per gallon in its original state:—

Soluble salts:— 8·903	Chloride of calcium, Chloride of magnesium	0·499
	Chloride of sodium	4·002
	Chloride of potassium	0·107
	Nitrates of magnesia or lime	a little
	Crenate and apocrenate of magnesia or lime	2·001
	Organic extractive matters	0·261
	Sulphate of magnesia	0·712
	Sulphate of soda	1·321
Insoluble salts:— 15·358	Carbonate of lime	7·961
	Carbonate of magnesia	1·550
	Sulphate of lime	0·240
	Peroxide of iron* and alumina*	2·990
	Perphosphate of iron*	minute traces
	Organic matters	0·411
	Silicic acid,* sand,* &c.	2·206
		24·261

Insoluble warp, separable by filter, 23·720.

B. *Analysis of the Warp itself.*

I.—Specimen separated by filtration from the first sample of water.

Composition:—	Quantity per Gallon.	Per Cent.
Organic matters	16·344	7·003
Carbonate of lime	22·813	9·775
Carbonate of magnesia	3·547	1·520
Potash and soda, existing in combination with silicic acid	0·199	0·085
Lime	2·111	0·905
Magnesia	6·640	2·684
Peroxide of iron	10·419	4·465
Oxide of manganese	traces.	traces.
Alumina	10·487	4·491
Perphosphate of iron	0·215	0·092
Silicic acid, sand, and undecomposed silicates	160·605	68·778
Sulphate of lime	evident traces.	evident traces.
	233·380	99·801

The warp from the second specimen of water was not subjected to analysis; it was, however, most probably, very similar in character to the preceding.

II.—Labelled "Specimen of warp from the Grimsby Dock, near the mouth of the River Humber."

The vessel in which it was contained being covered over carefully with bladder, this warp must have been in exactly the same state as when first deposited.

Specific gravity in its normal state at 60° Fahren.	1·5511
Specific gravity of anhydrous warp, as determined by means of oil of turpentine	2·3962

Composition in 100 *parts* :—

		As dried by exposure to air at ordinary temperature.	In normal condition.*	Anhydrous.
Water		6·250	47·495	..
Organic matters		10·750	5·942	11·489
Soluble salts of river-water, 3·019.	Chloride of magnesium	0·222	1·658	3·206
	Chloride of sodium and potassium	1·801		
	Sulphate of magnesia	0·360		
	Sulphate of soda	0·636		
Carbonate of lime		6·500	3·594	6·946
Carbonate of magnesia		4·700	2·597	5·023
Sulphate of lime		..	evident traces.	
Alkalies from decomposed silicates		0·320	0·177	0·342
Lime		0·700	0·387	0·748
Magnesia		3·060	1·691	3·270
Oxide of iron and alumina		12·000	6·632	12·825
Oxide of manganese			traces.	
Perphosphate of iron		1·050	0·580	1·122†
Insoluble siliceous residue		51·491	29·147	55·029
Loss		0·160	..	..
		100·000	100·000	100·000

The anhydrous warp contained 0·342 per cent. of nitrogen = 0·4152 per cent. of ammonia.

III.—This was labelled "Specimen of warp of about an average quality."

Composition in 100 *parts* :—

		Hygrometrically dried, at the ordinary temperature.	Anhydrous.
Water		4·000	..
Organic matters		6·650	6·927
Soluble salts of river-water 1·473	Chloride of magnesium	0·101	0·105
	Chloride of sodium and potassium	0·902	0·939
	Sulphate of magnesia	0·169	0·176
	Sulphate of soda	0·301	0·313
Carbonate of lime		7·850	8·177
Carbonate of magnesia		0·300	0·312
Sulphate of lime		0·100	0·104
Alkalies from decomposed silicates		0·450	0·469
Lime		0·650	0·677
Magnesia		2·500	2·604
Oxide of iron		4·850	5·052
Alumina		7·850	8·177
Oxide of manganese		traces	traces
Perphosphate of iron		1·000	1·040‡
Silicic acid		8·700	9·062
Sand, undecomposed silicates, &c.		53·627	55·866
		100·000	100·000

* These two last have been calculated from the first analysis.

† This is equivalent to 0·5278 gr. of phosphoric acid, or of triboric phosphate of lime (bone-earth phosphate) 1·1436 gr.

‡ This is equivalent to 0·1326 gr. of phosphoric acid and 0·2873 gr. of phosphate of lime.

The proportion of nitrogen present in the anhydrous warp amounted to 0·245 per cent. = 0·2975 per cent. of ammonia.

C. *Analysis of the Soils.* *

I.—Labelled "Sandy sterile soil, before warping."

Specific gravity at 56° Fahren. with interstices . .	1·4003
True specific gravity	2·4199

Composition per cent. of the soil after it had been exposed to the air for several weeks at 60° Fahren.

Water	1·060		
Sand, coarse and red . . .	93·994	Siliceous granules .	93·106
		Organic matter .	0·888
Stones (small)	2·040		
Undecomposed vegetable fibre, little or none.			
Fine earth (dried at 300° Fahren.)	2·892	Inorganic substances	1·579
		Organic matter .	1·313
Soluble saline matters . . .	0·014		
	100·000		

Water	1·0600	
Pure sand	93·1060	
Stones	2·0400	
Organic matters, insoluble in water and alkalis	0·5934	2·2000
Humine and humic acid	1·1500	
Apocrenic acid	0·1428	
Crenic acid	0·3138	
Chloride of calcium	0·0003	Salt, soluble in water, 0·0141
Chloride of sodium	0·0055	
Chloride of potassium	0·0014	
Sulphate of magnesia	traces	
Sulphate of soda	0·0069	
Carbonates of lime and magnesia . . .	traces only	
Lime	0·0007	
Magnesia and alkalis	minute traces	
Oxide of iron	0·2771	
Alumina	0·3899	
Sulphate of lime	traces	
Perphosphate of iron	0·0001	
Oxide of manganese	traces	
Silicic acid	0·1399	
Undecomposed silicates, and very fine insoluble silica, &c.	0·7722	
	100·0000	

100 grains of the soil contained of nitrogen 0·0715 grains, = 0·0868 grains of ammonia.

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* I should observe that in each of the three following analyses the fine earth from eight or ten thousand grains of the soils was employed.

II.—Labelled "Sandy soil, upon which warp has lain these fifteen years; the warp was eleven inches in thickness, and this specimen of soil lay immediately underneath."

Specific gravity at 56° Fahren. with interstices .	1·075
True specific gravity	2·106

Composition per cent. of the soil hygrometrically dried at 60° Fahren.

Water	2·000		
Sand	84·480	Siliceous granules . .	83·572
		Organic matter . .	0·908
Stones	1·400		
Vegetable fibre .	very little.		
Fine earth (anhydrous) .	11·943	Inorganic substances .	5·248
		Organic matter . .	6·695
Soluble saline matters .	0·177		
	100·000		

Water.	2·0000	
Pure sand	83·5720	
Stones	1·4000	
Organic matters, insoluble in water and alkalis	4·7860	7·6150
Humine and humic acid	1·8800	
Apocrenic acid	0·2394	
Crenic acid	0·6969	
Organic matters, soluble in water . . .	0·0127	
Chloride of calcium	0·0004	Salt, soluble in water, 0·1647
Chloride of sodium	0·0781	
Chloride of potassium	0·0429	
Sulphate of magnesia	traces	
Sulphate of soda	0·0433	
Carbonate of lime	0·4582	
Carbonate of magnesia	0·2949	
Sulphate of lime	evident traces	
Lime	0·1411	
Magnesia	0·2586	
Alkalis	0·1747	
Oxide of iron	1·1747	
Alumina	0·4079	
Oxide of manganese	traces	
Perphosphate of iron	0·2800*	
Silicic acid, and undecomposed silicates, &c. .	2·7666	
	100·0000	

The proportion of nitrogen contained in this soil amounted to 0·4551 grain per cent. = ammonia 0·5525.

III.—This specimen was labelled "Peat moor soil, before warping."

The hygrometrically dried soil contained per cent. of—

* This is equivalent to 0·1326 gr. of phosphoric acid, and 0·2873 gr. of phosphate of lime.

Water	11·000		
Roots, vegetable fibre, pieces of partly decomposed wood, &c.	40·001	Ash	15·246
		Organic matters	24·755
Sand	18·352		
Stones	few or none.		
Fine earth (anhydrous)	30·439	Inorganic substances	19·051
		Organic matters	11·385
Soluble saline matters	0·208		
	100·000		

Water		11·0000	
Pure sand		18·2140	
Organic matters, insoluble in water		36·2789	36·3468
Organic matters, soluble in water		0·0679	
Soluble saline matters directly extracted from the soil by water, 0·1401. From the incinerated wood, &c., 2·7759.	Chloride of calcium	0·0339	
	Chloride of magnesium	some.	
	Chloride of sodium	0·2716	
	Chloride of potassium	0·0216	
	Sulphate of magnesia	0·0353	
	Sulphate of soda	0·1665	
	Carbonate of soda*	0·8182	
	Carbonate of potassa*	1·5689	
	Alkaline phosphates*	traces.	
	Carbonate of lime	1·8514	
	Carbonate of magnesia	traces.	
	Sulphate of lime	1·6799	
	Lime	0·2312	
	Magnesia	0·0462	
	Oxide of iron and alumina	9·2789	
	Perphosphate of iron	evident traces.	
	Insoluble siliceous residue	18·4366	
		100·0000	

100 parts of the anhydrous soil contained 1·2660 grains of nitrogen = 1·5380 of ammonia.

D. *Analysis of the Crops.*†

I.—Horse-beans (*Vicia faba,* or *Faba vulgaris,* var. β).

	α.	β.	γ.	δ.
Sulphuric acid	2·650	1·340	1·660	..
Phosphoric acid	36·099	37·940	35·670	39·110
Potash	25·456	20·820	46·190	32·710
Soda	20·675	17·744	..	12·750
Chloride of sodium	2·101	2·467	..	..
Chloride of potassium	..	..	1·500	..
Lime	3·065	7·260	5·330	4·720
Magnesia	9·861	8·870	8·980	6·130
Alumina	traces.	..	..	..
Oxide of iron	0·061	1·030	..	0·660
Oxide of manganese	traces.	..	..	..
Silicic acid	0·032	2·460	0·510	0·470
	100·000	99·931	100·840	96·550

* Principally contained in the ashes produced by the incineration of the undecomposed wood.

† To prevent misunderstanding, I ought, perhaps, to remark here, that in the pre-

	α.	β.	γ.	δ.
Percentage of ash from the fresh grain .	3·298	undetermined	do.	do.
" " " dried grain	4·301	4·000	3·900	do.
" " nitrogen in the dried beans	4·612	undetermined	do.	do.

α. Labelled "These beans were grown on warped land, being the first crop after warping; produce 5 qrs. (40 bshls.) per acre. Previous to warping, this land was quite unproductive."

β. Analysis, by Bichon, of the inorganic constituents of a sample of similar beans, from Holland.

γ. By Boussingault, from Alsace.

δ. By Büchner, from Giessen.

II.—Wheat (*Triticum hybernum*).

	α.	β.	γ.	δ.	ε.
Sulphuric acid . . .	0·160	0·092	0·101	traces.	..
Phosphoric acid . . .	48·719	47·547	46·172	50·018	48·252
Potash	20·019	29·506	31·914	35·405	33·090
Soda	14·965	10·611	8·909	3·130	2·941
Chloride of sodium . .	1·667	0·540	0·313	traces.	..
Chloride of potassium .	..	..	..	..	..
Lime	1·360	0·993	0·897	2·200	5·616
Magnesia	12·919	10·600	11·602	9·097	10·101
Alumina	traces.	..	..	..	..
Oxide of iron . . .	traces.	..	..	..	..
Oxide of manganese .	..	..	..	..	..
Silicic acid	0·191	0·111	0·092	traces.	traces.
	100·000	100·000	100·000	99·850	100·000
Percentage of ash from the fresh grain	1·864	not estimated	1·909	not estimated	1·868
Percentage of ash from the dried grain	2·298	2·316	2·292	do.	2·461
Percentage of nitrogen in the dried grain . . .	2·611	not est[d.]	not est[d.]	not est[d.]	2·397

α. This sample was labelled "Wheat grown in succession after beans, being the second crop after warping; produce 4 qrs. (32 bshls.) per acre."

β. Marked "This wheat was grown the fifth crop after warping; two of which were oats, and three wheat; produce 4½ qrs. (36 bshls.) per acre."

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paration of the ashes of the various crops, I in every case adopted the precautions mentioned by M. Rose (Phil. Mag., vol. 30, No. 202, p. 369) for the purpose of avoiding any loss that might result from the volatilization of the alkaline chlorides. I did not, however, pursue the same method of analysis as the one he recommends.

γ. Marked "This wheat was grown upon land warped six years ago; the first crop was oats, then three crops of wheat in succession; produce 4 qrs. (32 bshls.) per acre."

δ. This specimen was grown on rich arable land at Horfield, near Bristol; produce unknown.

ε. Obtained from rich clay land near Pensford, about ten miles from Bristol. This is generally considered to be one of the best wheat-growing districts in Somersetshire.

III.—Oats (*Avena sativa*).

	α.	β.	γ.	δ.
Sulphuric acid	1·024	2·131	1·000	0·130
Phosphoric acid	17·643	9·739	14·900	21·530
Potash	13·133	9·771	12·900	13·970
Soda	7·154	4·612	..	1·500
Chloride of sodium	2·010	1·379	0·500	..
Chloride of potassium	..	..	..	..
Lime	4·176	6·818	3·700	4·220
Magnesia	9·321	7·732	7·700	8·820
Alumina	..	0·066	..	..
Oxide of iron	traces.	1·241	1·300	0·360
Oxide of manganese	..	..	..	..
Silicic acid	45·539	56·511	53·300	49·440
	100·000	100·000	95·300	99·970

Percentage of ash from the fresh grain	2·806	2·791	not determined	2·75
" " " dried grain	3·954	3·061	4·000	
" " nitrogen in the dried grain	2·364	1·691	..	..

α. This specimen was labelled "These oats were grown on warped land, and are the fourth crop in succession: *i.e.* first crop, oats; second and third, wheat; and fourth, oats; produce 8 qrs. (64 bshls.) per acre."

β. Labelled "These oats were grown upon natural sandy soil, which has never been warped (C. I.); produce $\frac{6}{8}$ qr. (6 bshls.) per acre."

γ. Analysis of the inorganic constituents of the oat, as given by Boussingault, in his '*Economie Rurale*.'

δ. Analysis of the same, by Way, 'Royal Agricultural Journal,' vol. vii.

IV.—Rye (*Secale cereale*).

	α.	β.	γ.	δ.
Sulphuric acid	0·514	2·606	0·170	0·510
Phosphoric acid	33·515	25·070	39·920	51·810
Potash	16·569	9·430	33·880	11·430
Soda	19·908	16·127	0·390	18·890
Chloride of sodium	1·617	4·100	..	..
Chloride of potassium	..	..	..	..
Lime	11·251	15·300	2·610	7·050
Magnesia	13·010	10·099	12·810	10·570
Alumina	..	0·501	..	..
Oxide of iron	..	2·161	1·040	1·900
Oxide of manganese	..	..	..	..
Silicic acid	3·616	14·606	9·220	0·690
	100·000	100·000	100·040	102·850
Percentage of ash from the fresh grain .	1·264	0·990	1·360	..
„ „ „ dried grain .	2·655	1·896	..	2·425
„ „ nitrogen in the dried grain	2·110	1·602	..	..

α. This specimen was obtained from warped land on the banks of the Ouse, Yorkshire; produce and locality unknown.

β. Labelled "This rye was grown upon the natural sandy soil, which has never been warped; produce 2 qrs. (16 bshls.) per acre. The land was contiguous to that upon which the preceding sample (β specimen) of wheat was grown."

γ. Composition of the inorganic constituents of rye as given by Way.

δ. Analysis of the same, by Bichon.

Concluding Remarks.

In the first place, if we compare the analysis of the warping water in its two different states, as taken whilst entering into and returning from the main drain, we shall see, that it has experienced very little change in composition during the process, except in the proportion of the warp or insoluble matters which it held in suspension; consequently, if we leave out of consideration what is owing to the saline ingredients of the water absorbed by the soil, it is evident that the whole of the increased fertility which is conferred upon land by warping is produced by the mud or silt which is deposited by the water. Nor, in fact, is the proportion of deposit so produced by any means inconsiderable; in the specimens examined, whilst the water in its former state contained $233\frac{1}{2}$ grains per gallon of insoluble matters separable by a filter, the second specimen contained only 24 grains. A gallon of the river-water, therefore, during the time which elapsed

between the taking of the first and second specimens must have deposited nearly half an ounce of warp. This being the case, it follows, that the land must have received about 8483 pounds or rather more than $3\frac{3}{4}$ tons of anhydrous warp per acre for every foot in depth of water that flooded it. This is taking it at a very low estimate, because, in the present instance, there was much fresh water in the river, and consequently the water contained less warp than usual. In good warping seasons the water of the rivers Trent and Ouse is often so excessively muddy, that, if a cylindrical glass tube of 12 or 15 inches in height be filled with it, there will be obtained an inch of sediment in less than half an hour. An instance occurred, a few years back, where a portion of the old channel of the Ouse, containing 800 acres, was deserted by an alteration in the drainage, and it was warped up to the height of 25 feet in less than six years, without any artificial aid whatever.

The question may be asked, Whence does this warp or mud come from? That it is not brought in by the sea is evident, because the water at the mouth of the Humber is perfectly clear and limpid; neither does it originate from land-floods, for these are always observed to injure the quality of the warp; it therefore can only arise from the action of the tidal waters upon the strata of soft shaly clay, which form the bottom of the Lincolnshire marshes, and in which, in all probability, the estuary of the Humber has itself been excavated: the organic matters being clearly derived from the cultivated land through which the rivers pass. The truth of this conclusion is moreover confirmed by the analyses (B), which exhibit a composition exactly similar to that we should expect it to possess were it formed under such circumstances. The composition of the warp, however, is very liable to vary according to the season of the year and the state of the weather. Thus, in very rainy or rough weather it generally contains a large proportion of coarse rocky *débris*, which is useless, if not injurious; and in the hot summer-months, there is a great increase to be observed in the quantity of common salt and other saline matters in consequence of the rapid evaporation of water from the surface.

Although the proportion of the really active fertilizing ingredients present in the warp is shown by the above analyses to be comparatively small, still, if we consider for a moment the largeness of the quantity of the warp applied to the land, we shall not fail to perceive that it is far from being contemptible—it must indeed be positively immense. Thus, if we take as data the composition of the warp as exhibited in the second analysis (B. II.), and the average depth at 18 inches, we shall find the weight of deposit per acre amount to about $2829\frac{1}{2}$ tons, containing of real anhydrous constituents $1485\frac{1}{2}$ tons; namely, of—

	Tons.	Cwts.
Soluble salts of river water	47	12½
Organic matters, containing of nitrogen 5½ tons	170	16½
Carbonate of lime, containing of lime 74 tons 2 cwts.	103	19
Carbonate of magnesia, containing 44 tons 15 cwts. of magnesia	74	11
Alkalis	5	1½
Lime	11	2
Magnesia	48	11
Phosphoric acid	7	16
Silicic acid, sand, oxide of iron, and other comparatively inert substances	1016	10½

Now, a six years' rotation consisting of one crop of beans, two crops of oats, and three of wheat, according to the preceding analyses (D), would only remove of—

	40 Bushels of Beans, weighing 2000.		128 Bushels of Oats, weighing 5120.		99¾ Bushels of Wheat, weighing 5985.	
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
Sulphuric acid	1	12	1	8	0	3
Phosphoric acid	23	12¾	25	5½	53	5½
Potash	15	15	20	15	30	10¼
Soda	13	10	10	4½	13	0¼
Chloride of sodium	1	6¼	2	14	0	15
Lime	2	0¼	6	0	1	5
Magnesia	6	4½	13	6	13	3½
Oxide of iron	0	0½	..		..	
Silicic acid	0	0¼	63	5	0	3
Inorganic constituents	64	13½	143	10	112	13½
Nitrogen	71	3	86	1	126	12*

—A quantity which will hardly admit of comparison with that added to the land in the form of manure. We can now understand how it is that warped land will allow of crop after crop of the most exhausting cereals being raised upon it without exhibiting symptoms of exhaustion. The above rotation, indeed, might be repeated more than thirty times, without the employment of any manure whatever, before the quantity of nitrogen and phosphoric acid—the two most important constituents of the soil—would be sensibly affected.

It must not be supposed, however, that I should wish the reader to understand that the entire value of the warp as a manure depends upon its chemical constituents, upon the proportion of nitrogen, phosphoric acid, and alkalis, &c., which it contains. In many cases, doubtless, one of the principal advantages that accrue to land so treated is caused by the alteration which is effected in its physical properties, in its porosity, its capability of

* In this calculation I have, of course, not taken into consideration the inorganic constituents, &c., of the straw, as it was supposed that these would necessarily be returned to the soil in some shape or other during the course of cultivation.

absorbing and retaining moisture, &c. Sandy and peaty soils, as I have already observed in a previous part of this paper, have been found by practical men to be the best natural soils to warp upon. The reason of this will be rendered immediately evident upon consulting my analyses of these particular soils before and after the operation. The first specimen or sandy sterile soil, it will be seen, was not only remarkably deficient in all those substances from which plants derive their nourishment, but it must also, from its sandy nature, have been constantly liable to be burnt up with drought. By the admixture of the warp, however, as is shown in specimen No. II., these disadvantages were counteracted, and it was converted into a rich arable soil, capable of furnishing nutriment to every description of crop.* It was also, at the same time, rendered more hygrometric, as will be seen upon consulting the following table, which shows the proportion of water retained by 100 parts of the soils, after they had been exposed to different degrees of temperature, &c.

	Dried at the ordinary state of the atmosphere.	Exposed to air saturated with moisture at 56° F.	Dried in a sand-bath at 100° F.
Sandy soil before warping . .	1·06	1·20	0·70
,, after ,, . .	2·00	2·90	1·30

A similar quantity of the different specimens of warp, dried at the same temperature, &c., contained respectively—

Warp from the river Humber (II.) .	6·25	8·80	not determined
Warp of about an average quality (III.)	4·00	4·80	2·16

* For the sake of comparison I have below given the analysis of a very fertile alluvial soil from Honigspolder, in Germany, made by an eminent chemist of that country, contrasting it with that of the warped sandy soil, as shown at page 104.

Sand and silica	64·800	86·3386
Stones, small	..	1·4000
Humus, soluble in alkali . . .	2·540	1·8800
,, insoluble in alkali . . .	5·600	4·7860
Organic matters soluble in water . .	..	0·0127
Apocrenic acid	..	0·2394
Crenic acid	..	0·6969
Nitrogenous matters	1·582	N. 0·4551
Chloride of calcium	..	0·0004
,, sodium	0·335	0·0781
,, potassium	..	0·0429
Sulphate of magnesia	..	traces.
,, soda	..	0·0133
Carbonate of lime	8·909	0·4582
,, magnesia . . .	..	0·2949
Sulphate of lime	0·357	evident traces.
Lime, in combination with silica . .	0·744	0·1411
Magnesia	0·840	0·2586
Alkalis	0·425	0·1747
Alumina	5·700	0·4079
Oxide of iron	6·100	1·1740
Oxide of manganese	0·090	traces.
Perphosphate of iron	..	0·2800
Phosphate of lime	0·430	
Water and loss	1·501	2·0000

The peaty soil, on the contrary, did not exhibit either of the bad qualities observed in the case of the sandy soil; it was not only sufficiently hygrometric, but it also possessed (with the single exception of phosphoric acid) every constituent necessary for the nourishment of plants. In this instance, therefore, nearly the whole of the improvement that the process in question was capable of effecting in the soil must have depended upon its mechanical alteration.

It is not only in the operation of warping that great fertility has been observed to be possessed by the mud of large rivers. Nearly the whole of Lower Egypt, it is well known, would be completely sterile were it not for the alluvion that is deposited upon the soil during the periodic overflowings of the river Nile. About the time of the summer solstice, between the months of May and June, continued heavy rains occur within the tropics, and these, being conducted into the bed of the river, swell its waters to such an extent that they overflow their boundaries, and inundate the lands on either side, carrying with them the fine mud and other matters which they have collected in their downward course through the hilly countries in the interior. This mud is gradually deposited upon the surface of the arid sand, and, as soon as the waters subside, forms a fertile soil, which is immediately sown down with rice and other grain crops by the natives, who ignorantly attribute this phenomenon to a special interference of a supernatural power for their benefit.

There is a very marked resemblance to be detected between the composition of the mud which is thus deposited by the above-mentioned river and that of the warp as it is shown by my own experiments. According to M. Regnault's analysis, which was published in the Memoirs of the Commission of Egypt (*Histoire Naturelle*, tome ii. p. 405), a specimen of the former, collected at 500 fathoms, contained of—

Water	11
Organic matters	9
Oxide of iron	6
Silica	4
Carbonate of lime	18
Carbonate of magnesia	4
Alumina	48
	100

A still more recent analysis, however, performed by M. Lassaigne (*Comptes Rendus*, No. 17, *Avril* 22, 1844), and undertaken at the request of M. de Las Casas, has proved it, after being dried at 212° Fahr., to consist of—

Water	10·70
Ulmic acid and nitrogenous organic matters	2·80
Peroxide of iron	13·65
Silica	42·50
Carbonate of lime	3·85
Carbonate of magnesia	1·20
Alumina	24·25
Magnesia	1·05
	100·00

It will be seen that in neither of the above analyses has any notice been taken of the soluble salts, phosphoric acid, or alkalis, although there is but little doubt that such must have been present. The fact is, however, that no attempt apparently was made to ascertain their presence, consequently *complete* dependence cannot be placed upon their results.

With regard to my analyses of the different crops, it is almost superfluous to make any observations upon them, as they may be said to speak for themselves. The only differences of any consequence that are to be observed are in the proportions of nitrogen and phosphoric acid. These are invariably much greater in the case of those crops that were grown upon the warped soils than in those obtained from the natural soils; as is also the proportion of ash. For the purposes of comparison, &c., it will be observed that in every instance in which I do not myself happen to have made an analysis of the inorganic constituents of similar crops grown upon good arable land, I have supplied the deficiency by giving one or more of the most trustworthy that are to be met with in other chemical works.

It not being my intention to enter upon the discussion, so important to chemistry and vegetable physiology, as to the limits within which any one of the inorganic constituents of a plant may vary, or to attempt to prove the truth or fallacy of Prof. Liebig's theory relating to these points, I shall not at this moment further refer to the subject; but shall leave it until a future period, when I hope to be enabled to do so with more justice than I could in such a paper as the present.

In conclusion, I cannot help expressing my warmest thanks to my friends, R. Thorold, Esq., of Great Grimsby, and Edward Barker, Esq., of Budleigh Salterton, for the many attentions and kindness they have shown me during the prosecution of the above investigation, and the much important information they have afforded me upon the subject. In fact, it was principally through the assistance of the former of these gentlemen, and that of his steward, Mr. Kirkby, that I have been enabled to obtain the requisite specimens of crops, &c., for the purposes of analysis.

Thornton J. Herapath.

Mansion House, Old Park, Bristol,
September 2nd, 1849.

VII.—*On the Accurate Levelling of Drains.* By Colonel Challoner.

To Ph. Pusey.

Dear Pusey,—As complaints are very often made of failures in draining, in consequence of drains choking or stopping up, especially where small pipes are used, I am induced to address a few practical remarks to you, not with the view of suggesting anything altogether new on the subject, but rather of calling the attention of many of our professional drainers, as well as the landowners and farmers, to a few matters of practical detail in the manner of cutting the drains and laying in the pipes, which, if attended to accurately, will greatly lessen the causes of complaint against the (much abused) "small pipe-tiles," for I have found by experience that the large-bore pipe-tile is equally subject to stopping up or choking, from the same cause as those of a smaller diameter.

It is generally the custom for drainers, when cutting drains, to try if they have the proper fall, by pouring a small quantity of water into the bottom of the drain, and if that runs in the direction they wish, they rest satisfied that they have cut the drain to a proper and regular fall; whereas if that cutting is proved or tested by the level, as hereafter described, it will be found to be anything but what it ought to be, especially where the fall from the head of the drain to the outfall is but trifling; and upon accurately testing it, it will, in most instances, be found that the workman has consumed more than the due proportion of the amount of fall that he has at command in one portion of the drain, while his tiles will lie dead and flat in another; and in many instances I have found the tiles lying in hollows, and following the *undulations of the surface*, as if on purpose to collect the sand or sediment which in a short time chokes the drain. I will now very briefly state how this may be avoided with little or no additional expense or trouble, and what I have myself practised with the greatest success and satisfaction to my workmen.

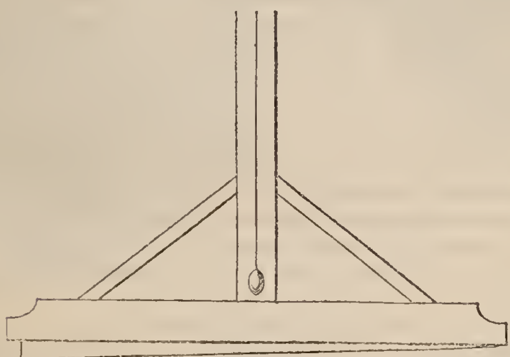
I first ascertain what amount of fall I can obtain from the head of my drain to my outfall: suppose the length of the drain to be 96 yards, and I find I have a fall of 2 feet, that gives me a fall of one quarter of an inch in every yard. I then take a common bricklayer's level, 12 feet long, to the bottom of which I attach with screws a piece of wood the whole length—1 *inch wider* at

one end than at the other—thereby throwing the level 1 inch out of the true horizontal line; when the drain has got to its proper depth at the outfall, I apply the broadest end of the level to the mouth, and when the plumb-bob indicates the level to be correct the 1-inch fall has been gained in the 4 yards; and so on I keep testing the drain as it is dug quite up to the head, when an unbroken, even, and continuous fall of 2 feet in the whole 96 yards has been obtained. The pipes are then laid in, and the level proved again on the pipes, which regulates any little inequalities in laying them in: this I have found that the men do willingly without any additional charge per rod; but even supposing that the men were to fancy that it was any additional trouble, a very slight increase in the pay per rod would be amply and fully compensated by avoiding, in many instances, the vexations attendant upon draining.

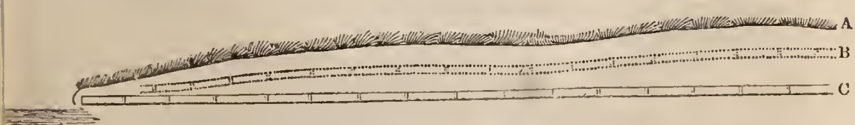
Believe me, truly yours,

C. B. Challoner.

Charles-street, Berkeley-square,
29th April, 1850.



Bricklayer's Level on a large scale. The false bottom may be made with a hinge, so as to answer for any fall.



A—Undulating surface of Land.
B—The line shows the position of very many drains when accurately examined by means of the level.
C—The plain line shows the position of a drain put in as recommended.

VIII.—*Farming of Gloucestershire.* By John Bravendar.

Prize Report.

Character of the Soils of the County, Farming, &c.—Gloucestershire presents a very uneven and broken surface. Its length is nearly 60 miles, and greatest breadth about 35 miles. Its contents have been stated by various authors to be 800,000, 695,252 (Rudge), and 1,100,100 acres. From a careful examination of the Ordnance sheets I make the total quantity to be 797,500 acres, including roads, rivers, waters, and wastes, and the Forest of Dean, containing about 23,880 acres.

The outlines which divide the soils of the county are so very irregular, that it is almost impossible to state accurately the quantity of each kind of soil. An approximate quantity is all that we can arrive at. The climate is variable. The Cotswolds and elevated portions are observed to be frequently covered with snow when there is none in the vale, and in descending from Birdlip to Whitcombe I have frequently been struck with the great difference in vegetation in the spring, and have felt, as it were, a great-coat warmer in the vale than on the hill. The more elevated position of the western verge of the Cotswolds, and the change in the quality of the land, are sufficient to produce this marked difference. This difference is seen more in arable than pasture land. Some years since the harvest was a fortnight or three weeks later on the hills than in the vale, but this is rarely the case now, the Cotswolds being somewhat more sheltered and the soil better cultivated. The introduction of bones has also tended to bring the crops *to an early maturity*, and the time of harvest has become more equalized.

Gloucestershire, considered in an agricultural point of view, naturally becomes classified into five divisions, as under:—

1st. The vale which lies south-east of the Cotswolds, and comprises a portion of the vale of the Isis or Thames, containing about 59,800 acres.

2nd. The elevated district, called the Cotswolds, containing about 297,800 acres.

3rd. The portion locally and emphatically called the "Vale," which admits of the following subdivisions, viz.:—Vale of Evesham; Vale of Gloucester; Vale of Berkeley, containing about 300,600 acres.

4th. The Bristol district, including the Kingswood and Coalpit Heath coal-fields, containing about 66,000 acres.

5th. The Forest of Dean and Ryeland district, containing about 73,600 acres.

The farming in each of those divisions differs a little from that

Geological Map of Gloucestershire.

REFERENCES TO PLACES ON THE MAP.

1. Stratford upon Avon.
2. Evesham.
3. Winchcomb.
4. Tewkesbury.
5. Cheltenham.
6. Gloucester.
7. Newnham.
8. Coleford.
9. Chepstow.
10. Monmouth.
11. Berkeley.
12. Wotton Underedge.
13. Stroud.
14. Minchinhampton.
15. Cirencester
16. Northleach.
17. Stow on the Wold.
18. Burford.
19. Fairford.
20. Lechlade.
21. Cricklade.
22. Tetbury.
23. Malmesbury.
24. Swindon.
25. Bath.
26. Bristol.

ARRANGEMENT OF STRATA.

M. Trap of Malvern and Torlworth.
F. Lower Silurian.
E. Upper Silurian.
C. Old red Sandstone.
Q. Carboniferous Limestone.
K. Millstone Grit.
D. Coal-measures.
N. New red Sandstone.
A. Lias.
P. Fuller's Earth.
G. Inferior Oolite.
O. Great Oolite.
I. Forest Marble.
B. Cornbrash.
S. Oxford Clay.
T. Coral Rag.
J. Kimmeridge Clay.
R. Portland Oolite.
L. Greensand.
H. Alluvium.

in the others, as the soil and climate differ, and in some degree as the wants and pursuits of the population of each require. To do justice to the various methods practised in those divisions will require me only particularly to describe the farming practised in two of those divisions, on the Cotswolds and the "Vale." Many of the practices are common to all the divisions: I need therefore only introduce a few remarks respecting the others.

Few counties having the same geological formations exhibit the soil of the rock in so pure a state or so free from the débris of other formations as Gloucestershire, and especially that portion called the Cotswolds. This may probably be the cause of the peculiarities of management which are so striking and so puzzling to persons who dream of the introduction of one universal system applicable to all soils and climates. The soils generally, with slight exceptions, have been derived from the rocks or subsoils on which they rest, and in consequence a geological map will afford the best index to the character of the soils. Our agricultural division will but little interfere with the geological. The vale of the Isis or Thames includes the geological subdivisions called Oxford clay, Kelloway rocks and sands, cornbrash and forest marble, and Bradford clay. The Cotswolds comprise the great oolite, fullers' earth, and part of the under or inferior oolite. "The Vale" comprises the lias and new red-sandstone. The Bristol district comprises a mixture of lias, old and new red-sandstones, mountain limestone, &c.; and the Forest district, the old and new red-sandstone, magnesian limestone, &c. The geology, agricultural botany, and entomology of the county will be best understood from the particulars on the following page :—

Geology of Gloucestershire.—The subsoil of nearly all the county consists of secondary strata, from the Oxford clay to the Caradoc sandstone inclusive.

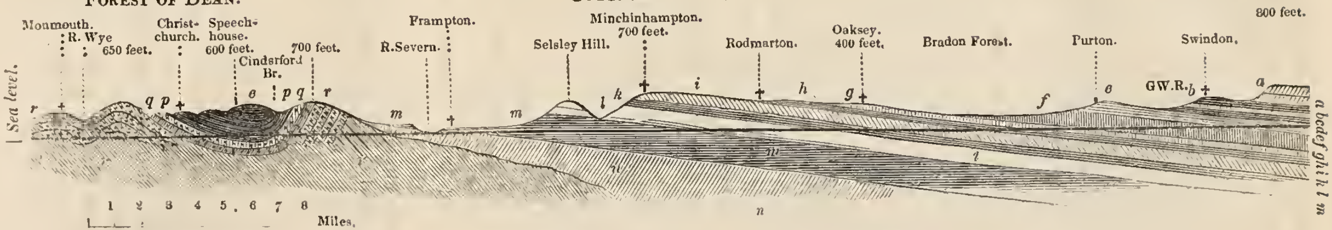
Tertiary formations are entirely wanting, and primary rocks only met with near Tortworth.

Modern deposits of marine origin (diluvium) seldom interpose between the soil and more ancient strata, although in most of the Cotswold valleys, and rarely on the hill, there are accumulations of limestone gravel, the last traces of the agency by which these valleys were made.

Modern river deposits (alluvium) are of considerable extent, and still increasing from the marsh land bordering the Severn, and some smaller tracts, beside the Avon, the Isis, and other streams. These tracts are fertile in proportion to the varied regions through which these streams have flowed, and the nature of the sediment still periodically spread over them by floods.

The county includes two considerable coal-fields, from which it is chiefly supplied with "fossil fuel." Coal is also brought from

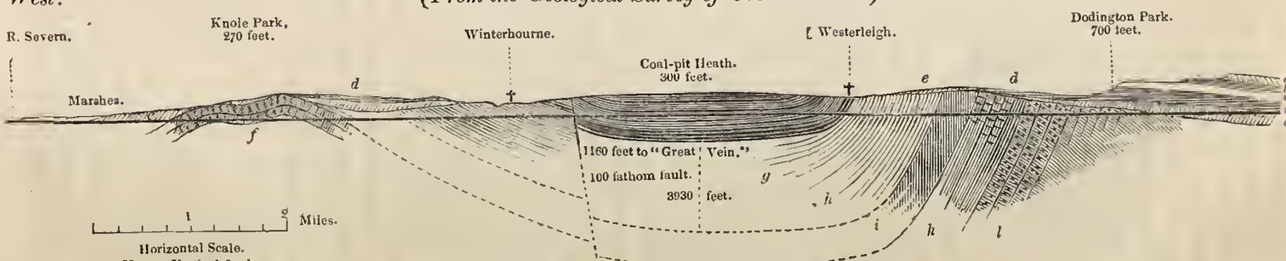
1. General Section, from MONMOUTH to the Chalk Downs of WILTSHIRE.



	Feet.		Feet.		Feet.		Feet.	Feet.
a. Chalk, Wiltshire Downs	400—1000	*f.* Oxford clay	500	*k.* Fuller's earth	50— 120	*o.* Coal-measures, Bristol	5080—Dean For.	2330
b. Iron-sand and gault-clay	300— 500	*g.* Cornbrash	3— 30	*l.* Inferior oolite	50— 250	*p.* Millstone grit „	1200 „	450
c. Portland-stone, Swindon-old-town	100	*h.* Forest marble	10— 50	*m.* Lias	500	*q.* Carbonif. limest. „	2338 „	800
d. Kimmeridge clay	200	*i.* Great oolite	50 — 120	*n.* New red sandstone	250—1000	*r.* Old red sandstone		5620
e. Coral rag	50— 100					*s.* Silurian strata (Mayhill and Tortworth).		

2. Section showing the relation of the BRISTOL Coal-Field to the Oolitic Hills.

(*From the Geological Survey of Great Britain.*)



a. Great oolite, 30 feet; *b.* Fuller's earth, 120; *c.* Inferior oolite, 170; *d.* Lias, 300; *e.* New red sandstone; *f.* Carboniferous limestone; *g.* Pennant sandstone; *h.* Lower shales; *i.* Millstone grit, 1200 feet; *k.* Carboniferous limestone, 2338 feet; *l.* Old red sandstone.

Staffordshire by canal, and from South Wales by sea. But for all this, and the facilities of rivers, canal, and railways, coal is still so expensive in the eastern hilly districts as to limit its beneficial employment in the operations of the farm. The prices range, according to circumstances, from 16*s.* to 22*s.* per ton.

The physical character of the county, its hills and valleys, and river channels, arise out of its geological structure, and, owing to the general absence of local deposits, there is an unusually close connexion between the character of the soils and that of the strata beneath. The geological map of this county preserves therefore a much higher agricultural value than does one of any of the eastern counties, where the regular strata are covered up by enormous and variable beds of gravel and clay, whose boundaries have not yet been surveyed. A glance at this map will show the districts into which I have divided the county.

The *section* shows that the strata of Gloucestershire form two larger distinct groups, of which the lower (and older) includes the Silurian rocks, old red-sandstone and carboniferous system, whilst the newer secondary comprises the new red-sandstone, lias, and oolites.

The older * secondary strata occupy the western part of the county, and have an aggregate (maximum) thickness of about 3¼ miles; they are often highly inclined, and the hilly character of their surface is chiefly due to the action of mechanical forces, by which they are forced sometimes into the form of a dome (Tortworth and Berkeley), at others into that of a trough or basin. These older rocks are the depositories of the mineral wealth of the county; in them are found coal, iron, and lead ore, whilst, agriculturally, they have little comparative value (if we except the old red marls of Herefordshire), because they consist chiefly of extremely hard sandstone and limestone, forming steep-sided hills, where little soil forms or accumulates.

The newer secondary strata have an average thickness scarcely exceeding 1500 feet at the deepest part (Lechlade); but, owing to their nearly horizontal position, they overspread four-fifths of the county, resting "unconformably" on the edges of the former rocks, which they overlap, so that the new red-sandstone is sometimes found to repose on its nearest relative (in age), the coal-measures; at others, on the old red, or Silurian. This is important to all land-owners to remember, as it shows the extreme uncertainty attending operations for coal in untried districts.

I will now notice briefly each of the strata represented on the map, beginning with the lowest:—

* Usually now termed "Palæozoic," as containing the remains of the most ancient animals and vegetables of the globe.

1. The Trap rock of Tortworth is a volcanic rock, of the same nature with the hard varieties of modern lava, and is associated with the oldest Silurian rocks of the county. In composition it is very variable, passing from compact felspar to granitic and compact greenstone, claystone, and amygdaloïd: its colour varies from black to green, red, brown, and gray. It has been extensively quarried at Woolford, Horseley, and Micklewood Chace, and, when not already in a decomposed state, makes the most durable road-stone in the county.*

2. Silurian rocks occur in the Vale of Berkeley, extending from Tortworth to Pyrton Passage, also at May Hill, Ledbury, and between Much Marcle and Newent. At May Hill the strata have the following order and thickness:—

	Feet.
Wenlock limestone, sandstone, shale, and limestone	700
Wenlock shale	1,000
Woolhope limestone	240
Caradoc sandstone, shale, and sandstone	440
	2,380

In the middle of the Wenlock limestone series is a bed, 25 feet thick, of red dolomitic limestone containing 28 per cent. of carbonate of magnesia. See Morton, 'Silurian Rocks of Whitfield.'

3. *Old Red-Sandstone.*—This formation occurs near Bristol in the Vale of Berkeley, and surrounds the Forest of Dean. In the adjoining counties, Hereford, Brecon and Radnor, &c., it occupies an area of 2100 square miles, and forms hills—the Beacon of Brecon, 2682 feet high. Between Howl Hill, in Forest of Dean, and Much Marcle, its thickness has been measured by the geological surveyors:—

	Feet.
Sandstone and conglomerate	3,983
Sandstone and marls	790
Marls and cornstone	847
	5,620

Cornstone is the local name of the impure limestone which is sometimes found in this formation.†

The *marls* have rendered the valleys and plains of Herefordshire extremely fertile: they occur at Whitfield Farm. See Morton on Soils.

But the conglomerate whose enormous mass surrounds the Forest of Dean forms only picturesque hills capable of very little cultivation. The large proportion of the peroxide of iron, which causes the characteristic colour of the formation, does not appear of itself to be prejudicial to vegetation; but the absence of almost all organic remains is probably attended by a very general deficiency of carbonate, and still more of phosphate, of lime in the soils of the old red-sandstone.

4. *Carboniferous Limestone.*—Near Bristol this formation consists of—

* See an account, by Thomas Weaver, Esq., in the Trans. Geo. Soc.

† Analysis of cornstone and red marl:—

	Cornstone.	Red Marl.
Carbonate of lime	69·3	0·2
Peroxide of iron	2·2	9·6
Silica	19·5	64·3
Alumina	7·2	21·1
Water	0·9	4·5
Traces of chlorides, sulphates, and loss	0·9	—
Traces of chloride of sodium, and loss	—	0 3
	100	100

	Feet.
Limestone, marl, and sandstone, often red . .	400
Central portion, chiefly thick-bedded gray limestone .	1,438
Lower limestone shale; alternations of brown shale, marl, and limestone	500
	2,338

In the Forest of Dean its thickness is only one-third of the above:—

	Feet.
Upper portion	146
Central	480
Lower shales	165
	791

It extends below the whole of both these coal-districts, and its outcrop forms a zone of calcareous hills encircling them, with the exception of certain spaces where it is overlapped by the coal-measures, or concealed by the new red-sandstone.

The limestone beds consist chiefly of corals, encrinites, and shells, imbedded in calcareous matter, itself produced from the destruction of skeletons of marine animals. Some of these limestones have an oolitic structure, others are dolomitic, others siliciferous, and there are beds of nodular chert in horizontal layers like the flints in the upper chalk.

Near Lower Perlieu, in the Forest of Dean, the limestone contains much hœmatite iron-ore, which has long been extensively worked; but neither the lead-ore nor coal so abundant in the same stratum as in the north of England.

The thick compact beds are a marble much used for mantel-pieces, pillars, &c.; it is extensively quarried near Bristol as a road-stone, for which purpose it is carried as far as Cirencester and Tewkesbury, and it affords the strongest lime in the county.

Owing to its great hardness the soils upon this rock are usually thin, and to a great extent remain in sheep-walks; the natural herbage resembles that of the more elevated parts of the Cotswolds and Chilterns, where sheep's-fescue and burnet abound: but the carboniferous limestone has a more barren and subalpine character, from the absence of the juniper, the gorse, and the fern, which often clothe the oolite and chalk. See Morton's account, 'Whitfield Farm.'

5. *Millstone Grit.*—The lowest division of the coal-measures is still unproductive in this part of England, and hence termed by the miners of South Wales the "Farewell Rock." It is a coarse quartzose sandstone, much used for millstones.

In the Forest of Dean it is from 265 to 455 feet thick, and the Bristol coal-field from 950 to 1200 feet, with one seam of coal 400 feet from the base. The soils above are for the most part very poor and sterile.

6. The coal-measures consist of alternating beds of sandstone and argillaceous shales, with occasional marl-beds and coal-seams. Beneath every bed of coal is a peculiar layer of sandy clay, from a few inches to 4 or 5 feet in thickness.

The Bristol coal-field (see Map and Section) may be divided into three portions—

	Feet.
Upper sandstone and shales	1,800
Hard sandstones, called "Pennant" . . .	1,725
Lower shales	1,565
	5,090

It contains 37 beds of coal, altogether amounting to 78 feet, whilst the separate beds range from a few inches to 3 or 4 feet, and in single instances amount to 5 and 6 feet.

The coal-measures in the central parts of Dean Forest are 2310 feet deep (see Section), of which the upper shales amount to 1255 feet, and the central sandstones to about 1055 feet: the lower shales are wanting. There are 27 beds of coal, making an aggregate thickness of 40 feet 8 inches. These seams vary from 1 or 2 inches to 2 or 3 feet, and in one instance (the Coleford High Delf) to 5 feet.

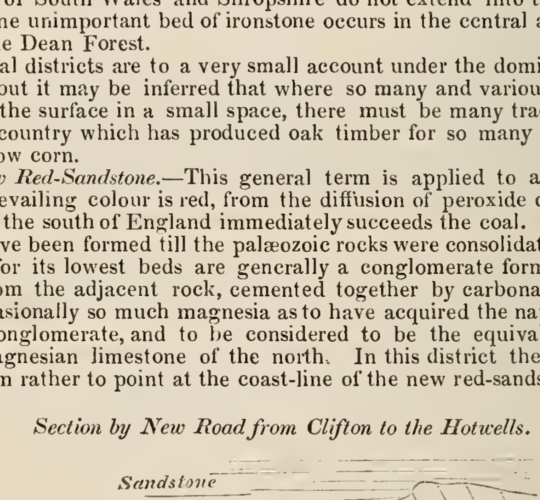
At Bowlsden, near Newent, a bed of coal 5 feet 6 inches thick was formerly worked in a small tract of coal strata, which descend eastward under the new red-sandstone and oolites up the valley of the Severn; but even here, though found at the depth of only 120 feet, the works were abandoned on account of the bad state of the roof above the coal.

The great and valuable deposits of argillaceous iron-ore in the coal-measure of South Wales and Shropshire do not extend into this county, though one unimportant bed of ironstone occurs in the central and highest part of the Dean Forest.

The coal districts are to a very small account under the dominion of the plough, but it may be inferred that where so many and various substrata come to the surface in a small space, there must be many tracts of good soil. A country which has produced oak timber for so many ages would surely grow corn.

7. *New Red-Sandstone.*—This general term is applied to a formation whose prevailing colour is red, from the diffusion of peroxide of iron, and which in the south of England immediately succeeds the coal. It appears not to have been formed till the palæozoic rocks were consolidated and upheaved, for its lowest beds are generally a conglomerate formed of fragments from the adjacent rock, cemented together by carbonate of lime, with occasionally so much magnesia as to have acquired the name of magnesian conglomerate, and to be considered to be the equivalent of the great magnesian limestone of the north. In this district the conglomerates seem rather to point at the coast-line of the new red-sandstone.

Section by New Road from Clifton to the Hotwells.



In the Bristol district the magnesian conglomerate is succeeded by red marls, very little sandstone intervening; but in the vales of Gloucester and Worcester the red-sandstone forms a lower division of great thickness, whilst the marls above contain the sulphate of lime, salt-mines, and brine springs, for which Droitwich and Northwich are famous.* At Aust Cliff,

* On the soils above the saliferous marls many plants have been observed which, requiring salt or soda in large quantities, usually grow only by the sea.—(See Ure's *Dictionary of Arts*, &c., 'Salt.') Mr. Buckman has suggested, with great probability, that these plants were introduced there when the Severn was an arm of the sea.—*Tran. Brit. Assoc.*, 1847. 'Straits of Malvern, 1849.'

on the Severn, the red marls are 121 feet thick; they rest on the upturned carboniferous limestone, and are covered by the lias.

At Westbury-on-Severn the marls are 357 feet thick. These marls are often variegated with blue and red tints, the blue increasing towards the surface, and in the fissures where water descends; the blue colour is attributed to the de-oxidating influence of vegetable matter in the marls, as the old red-sandstone, where the deep red peroxide of iron is often converted into a proto-salt, giving the marl a greenish or bluish colour.

In composition these marls are very complicated, and hence the fertility of the district and the peculiarities of the mineral waters at Cheltenham and elsewhere, which rise up from them, dissolving out the salts and forming new combinations in their progress. These waters contain sea-salt and the sulphate of soda and magnesia, and sometimes also sulphate of lime, oxide of iron, chloride of magnesia, iodine and bromine.*

The composition of the red marl of Aust Cliff is given by Sir Henry Delabeche:—

Silica	48·69	Potash	3·15
Protoxide of iron	4·79	Phosphoric acid	trace
Peroxide of iron	9·09	Sulphuric acid	0·27
Alumina	8·77	Chlorine	trace
Lime	8·68	Carbonic acid	8·56
Magnesia	0·94	Organic matter	1·18
Soda	0·53	Water and loss	4·25

North of Newent the red-sandstone division emerges from beneath the marls, and begins to occupy a wide space parallel with the Malverns.

With the sandstone are beds of conglomerate full of rounded pebbles of the older rocks, especially the quartzose rock of Bromsgrove. These sands, often in beds, are sometimes quite loose, and easily blown by the winds, so that not even gorse or larch will grow on them; whilst the conglomerates are mere gravel beds, the pebbles of which are used for mending roads.

8. Lias.
9. Inferior oolite.
10. Fuller's earth.
11. Great oolite.
12. Forest marble.
13. Cornbrash.
14. Oxford clay.

These latter geological strata being those on which the principal farming of the county is carried on, I have given a description of the soils in the articles on the farming of the Vale of the Thames and the Cotswolds, and the farming of the "Vale," thinking it desirable not to further burden this Report with a scientific description.

Agricultural Botany of the County.—Certain groups of our native plants are well known to afford valuable indications of the barrenness or fertility, and also of the quality of soils, since, like the cultivated crops, they require an abundant supply of particular mineral substances, and will not flourish where these are absent from the ground. A practised eye will often detect changes in the character of the natural herbage, where there is no apparent difference of physical condition, and those changes point out an alteration in the soil. To give their full value to such indica-

* See Murchison's 'Geology of Cheltenham.'

tions, it is still necessary to have analyses of the ashes of a number of our native plants, but in the mean time it is desirable to multiply observations on their distribution and range, since the information which already exists is very unsatisfactory, few botanists taking the trouble to notice the soil or even the precise locality of the plants they collect and catalogue.

The Flora of Gloucestershire consists almost entirely of those plants which characterize the agricultural regions of Central England and Germany; the highest hills in the county ranging only from 800 to 1100 feet, we find on them no traces of northern vegetation, although a few species (like the Pyrolas) do not extend further south, and the rocky districts are favourable to the growth of several ferns not found in the eastern counties. Plants of southern origin are also scarce in the centre of the county, but become more apparent towards Bristol; such are

Briza minor.	Rubra peregrina.	Lavatera arborea.
Linaria elatine.	Scilla autumnalis.	Pæonia corallina.
Monotropa hypopitys.		

The two last grow on the Severn Islands, beyond the limits of this county.

Much more obvious is the grouping of the native plants depending upon *soil;* all are supposed to have originally migrated from the East, but those which required a calcareous soil have been arrested along the escarpment of the Cotswolds, a boundary which many of them nowhere pass. Here are found nearly all the characteristic plants of the chalk downs of Kent and Wilts, as the following list will show :—

*Clematis vitalba.	*Pyrus aria.	Galeopsis ladanum.
Anemone pulsatilla.	Sison amomum.	Fagus sylvatica.
*Aquilegia vulgaris.	Pastinaca sativa (wild).	Juniperis communis.
Thraspi perfoliatum.	*Daucus carota (wild).	Taxus baccata.
*Reseda lutea and luteola.	*Viburnum lantana.	Epipactis grandiflora and latifolia.
*Helianthemum vulgare.	*Asperula cynanchica.	Orchis pyramidalis.
*Polygala vulgaris.	*Scabiosa columbaria.	—— mascula.
*Linum catharticum.	Carduus eriophorus.	Ophrys musifera and apifera.
*Anthyllis vulneraria.	*—— acaulis.	Convallaria polygonatum.
Astragalus hypoglottis.	Petasites vulgaris.	Carex digitata.
*Hippocrepis comosa.	Tussilago farfara.	Avena pubescens.
*Lathyrus aphaca.	Campanula glomerata.	Bromus erectus and pinnatus.
*Onobrychis sativa (cultivated).	Phyteuma orbiculare.	Polypodium calcareum.
*Prunus cerasus.	Gentiana amarella.	
*Spiræa filipendula.	Chlora perfoliata.	
*Poterium sanguisorba.	Origanum vulgare.	

Note.—The species marked with an asterisk (*) are abundant on the chalk downs.

It is also worthy of remark that several native land-snails abound equally on the chalk downs and Cotswolds.

Helix virgata and lapicida.	Bulimus lachrymensis.
—— pomatia.	Pupa juniperi.

On the clay-marl and clays those plants prevail which require, or can least withstand, the action of stagnant water. Amongst the most prevalent are

Genista tinctoria.
Chrysanthemum leucanthemum.
Carduus palustris.
Linaria elatine and spuria.
*Gymnadenia conopsea.
*Orchis latifolia.
Allium ursinum.
——— vineale.
*Juncus effusus.
*Carex glauca and vulgaris.
Agrostis stolonifera.
Alopecurus agrestis.
*Aira cæspitosa.
*Equisetum telmatia and arvense.

Those marked with an asterisk (*) indicate want of drainage in pastures.

If now we pass on to the sandstone districts, west of the Cotswolds, we shall find the natural herbage extremely altered in appearance by the suppression of the calcareous plants and the appearance of numerous *sand-plants;* the foxglove now mingles with the bell-flower, the heath blends with the heather, and the dwarf-furze with the gorse, common to both districts. Of the following list, those marked with an asterisk (*) appear especially to characterize sandy districts, and are equally absent from the Cotswold hills:—

*Aira præcox.
*—— flexuosa.
*—— caryophyllea.
*Erica cinerea.
*Digitalis purpurea.
*Sculeranthus annuus.
*Spergula arvensis.
*Arinaria rubra.
*Aribis thaliana.
*Ornithopus perpusillus.
*Onobus tuberosus.
*Ulex nanus.
*Teacrium scorodonia.
*Hieracium boreale.
Chrysanthemum segetum
Vaccinium myrtillis.
*Lastræa dilatata.

Even the parasitic miseltoe and dodder (Cuscutata epithymum) disappear with the orchards and heaths from the hills. A few weeds, which are so agriculturally, and which abound in arable land, also deserve mention:—

Sinapis arvensis.
Torilis infesta, stony fields.
Glyceria rigida, ditto.
Poa compressa, ditto.
Bromus secalinus, ditto.
Bartsia odontites, marls.
Allium vineale, ditto.
Avena fatua, clays.
Papaver rhœas, sands.
Chenopodium album, ditto.

In the borders of pastures Allium ursinum and Melilotus officinalis sometimes grow, and injure the quality of milk.

The following plants are, perhaps, more characteristic of the climate of the Cotswold valleys than the soil. Their names are given because they are amongst the most interesting or conspicuous members of the Flora:—

Epilobium angustifolium.
Convallaria bifolia.
Vicia sylvatica.
Alchemilla vulgaris.
Helleborus viridis.
Geranium pratense.
Dipsacus pilosus.
Bryonia dioica.
Tamus communis.
Gagea lutea.
Saratula tinctoria.

Entomology of the County.—The entomology of the county has been too little investigated to exhibit any marked peculiarities. Those tribes of insects which attack timber, like the stag-beetle and capricorn-beetle, are chiefly found on the western side of the county; whilst the wide extent of open tillage land on the east

has encouraged the multiplication of several families which are extremely destructive to crops. The wireworm-beetles (Elatenda), golden-beetles (Chrysomelida), including the numerous species of turnip "fly," and other vegetable feeders, are individually, as well as specifically, but too abundant. More than 100 species of weevils (Rynchophora) have been taken by Mr. Joshua Brown and Professor Woodward in the neighbourhood of Cirencester.

There are reasons for believing that the ordinary migrations alone, even of insects, are *slow*, and that the co-operation of the farmer in adopting methods of *prevention* would be attended with more success than is believed. The most obvious practices to be recommended are, 1st, paring and burning; 2nd, the cultivation of the hedgerows: nor should the encouragement of insect-eating birds be deemed less worthy of the farmer's attention than the protection of game.

The Vale of the Isis or Thames.—This, our first agricultural division, comprises but a small portion of the county, and lies on the south-eastern side, extending from Didmarton, past Tetbury, Cirencester, and Barnsley, to Eastleach. From Didmarton to Cirencester it little more than skirts the border of the county, scarcely being a parish in width, but at Cirencester it widens considerably; and from Barnsley Park to the outside of the county at Down Ampney, its breadth is not less than 6½ miles. Very little of the Oxford clay, except in the parish of Minety, exhibits its natural quality of tenacity: it is almost entirely covered with oolitic gravel of several feet in depth. The Kelloway is scarcely worthy of notice; some sandy hills at Driffield and on the north-west portion of Minety belong to this division. The cornbrash is more fully developed, and covers not quite one-third of this district, but the soil partakes of the character of the forest-marble in consequence of its being so thin and in many parts denuded. The forest-marble and Bradford clay form the largest portion of this division. Cirencester is situate in a vale from which this soil has been denuded, and a bed of gravel deposited from the destruction of the oolite at the time of the formation of the valley of the Churn.

The fences in the vale of the Thames are principally quickthorn hedges, and the fields are rather small, except on the gravel of Down Ampney and Kempsford, averaging about 7 acres.

The size of the farms is very variable, ranging from 50 acres to 500 or 600, or occasionally 700 acres. 5 or 6 per cent. is occupied by hedges and ditches, which might generally be reduced to 1½ per cent.: this has been done some time by some of the best farmers. The plan of reducing the hedges, and after-

wards keeping them cropped, promises soon to be almost a general practice.

This district is remarkable for the excellence of the water-meadows everywhere formed in the valleys of the Churn, the Coln, the Windrush, the Leach, and the Isis. The waters of those rivulets issue from the highly calcareous rocks of the Cotswolds, and in their way to the Thames advantage is taken of watering the meadows in the vales in almost every imaginable way. The water-meadows of South Cerney have long been known, and are even said to have been the first formed in England. This subject is of the greatest importance to the agriculturist; and were many a farmer of the North of England to reside here one year, he would return fully sensible of the great loss he has been annually suffering from the want of knowledge to supply the principles of *watering* to his practice. It would be trespassing, or I could point out many spots in Yorkshire where it would be easy to water hundreds of acres, and thus permanently more than double the value of such land, and by doing so enable the farmer with safety to drain and break up some of his unprofitable and rushy pastures. This subject is of such importance, and so little understood and practised in many parts of England, where it might be rendered subservient to very great improvements, that I have introduced the plan of a water-meadow, and described the method of watering and working it, which will be found in a subsequent part of this report.

A portion of the vale of the Isis, embracing the parishes of Kempsford, Down Ampney, and parts of Lechlade and South Cerney, possesses a soil of opposite characters. The Thames meadows, which are occasionally under water by the overflowing of the river, a little upland pasture, and a small portion of arable, are on the Oxford clay. From the meadows is cut as good feeding-hay as any country will produce; but the crop is not heavy, averaging rather under than over a ton per acre. The hay is liable to be lost from summer floods. The upland grass produces good butter and cheese, but the arable is very heavy working land, scarcely paying for ordinary cultivation. The draining which is now being done will tend to lessen the expenses and increase the produce; it will also be rendered safer for sheep whilst feeding off clover, &c. in wet summers, which is the practice as a preparation for corn. The farmer who occupies lighter lands endeavours to keep his stock off the heavy tenacious soils in winter. It is customary to give the very tenacious soils a whole summer fallow once in seven years, and sometimes oftener.

The usual course is green crops, pulse, and corn alternately. The following system, amongst others, is adopted :—

1st year. Summer fallow.
2nd „ Vetches, fed with sheep.
3rd „ Oats and sown clover.
4th „ Clover; 1st crop mown for hay, 2nd crop fed.
5th „ Wheat.
6th „ Vetches, fed with sheep.
7th „ Wheat.

Another portion of this division, as has been already stated, is covered with oolitic or calcareous gravel. The gravel is formed of the débris of the great and inferior oolites. The quality of the soil varies very much, part being a deep friable loam on high-coloured gravel, and part a light, porous, moory soil on a weak white gravel, having the water stagnant within a foot of the surface nearly half the year, for want of the means of escape to the adjoining rivers. The rotation of cropping is variable. The four or eight course is adopted on the best land, and under good management produces good crops of roots, vetches, clover, barley, and wheat. The following mode of cropping is followed by one of our best cultivators:—

1st year. Swedes on the ridge.
2nd „ Barley, drilled.
3rd „ Broad clover.
4th „ Wheat, drilled.
5th „ Rye and vetches, fed off with sheep, and afterwards swedes and turnips drilled on the flat.
6th „ Barley.
7th „ Rye-grass, hop-clover, or rape.
8th „ Wheat, and on the lightest land a few white peas.

Some of the lighter land is farmed on the following seven-year course:—

1st year. Pared and burned for early turnips, which are fed off with sheep.
2nd „ Wheat, and sown with seeds.
3rd „ Seeds, fed.
4th „ Pared and burned for turnips, which are fed off with sheep.
5th „ Barley sown with seeds.
6th „ Seeds which are mown for hay.
7th „ Ditto fed.

The worst of the moory part, locally called "Bomer," is not considered capable of growing wheat to a profit, and produces very thin samples even of barley and oats. The Italian and other rye grasses sown with barley are often seeded. These crops are not at all unlikely to be the most profitable of the course. After lying in grass two or three years, the land is pared and burnt for turnips; but even a good crop of turnips will scarcely keep sheep in good store condition. It is, therefore, not accounted good stock land. Whether this is to be attributed solely to the poverty of the produce, or to the damp and unhealthy state of the land on which the sheep are folded, has not been

determined. Probably both have a share in creating the mischief. The sheep always have a pale, unhealthy appearance, altogether different from the white coat obtained from being on pasture land. A third portion of this district, which cannot be more accurately defined than by enumerating its geological subdivisions, consists of the cornbrash, forest-marble, and Bradford clay. The difference in this land and that immediately westward, which rests on the Bath freestone, arises from the rock being in thin layers of a slaty character, intermixed with thin beds of clayey marl, and the beds of Bradford clay, varying in thickness from a few inches to several feet. This causes it in many places to be very wet, and to require draining, which, on account of the rock being so hard and near the surface, is expensive. In many places the plough rubs along on the surface of the rock, as if on a pavement. I have often been obliged to pay as much as 1*s.* 6*d.* per perch for digging 3-feet drains, and have obtained from them more stones than were necessary to make the drains. I have more than 150 acres of this kind of draining under hand at the present moment. The colour of the soil varies from a pale brown to a brownish red, being mostly a very adhesive calcareous clay, not often scouring from the plough or other implements. Where the soil is thin, and having at a few inches from the surface the thin planky rock, it is liable to burn in summer. This soil produces good wheat, clover, vetches, oats, and peas; but turnips, barley, and beans are uncertain. The rotation of cropping is the four or five course, as follows:—

First Rotation.

1st year. Swedes or turnips.
2nd ,, Barley or oats.
3rd ,, Clover or rye-grass and mixed seeds.
4th ,, Wheat.

Second Rotation.

1st year. Vetches fed off with sheep
2nd ,, Barley or oats and afterwards turnips.
3rd ,, Vetches or pulse.
4th ,, Wheat.

Third Rotation.

1st year. Roots.
2nd ,, Wheat.
3rd year. Clover, cabbage, vetches and other green crops.
4th ,, Wheat.

Fourth Rotation.

1st year. Swedes or turnips.
2nd ,, Barley or oats.
3rd ,, Mixed seeds mown for hay.
4th ,, Ditto, fed.
5th ,, Wheat.

Fifth Rotation.

1st year. Roots.
2nd ,, Barley or oats.
3rd ,, Seeds.
4th ,, Wheat.
5th ,, Pulse or vetches for seed.

It is only where high farming has been followed, by consuming corn, cake, or seeds, with the roots or other produce, that wheat has been planted every other year. The practice of following the roots with wheat, where the four-field course is adopted, is not to be recommended as a general practice, unless on good soils, well cultivated and highly manured. Wheat every other year

cannot be expected under the ordinary cultivation of our soils. The general practice has hitherto been only to plant a few acres of wheat after turnips.

About one-fourth of this district is in pasture and meadow. In it there are many small dairy-farms, producing cheese and butter of the same quality as in North Wilts, which adjoins. There are also some good water-meadows on the Coln, Churn, and other small rivers which run through it. Those meadows produce an early and abundant supply of grass for ewes and lambs, and other stock, which is exceedingly useful in the spring. The custom is to consume the first crop by keeping the sheep on the land till May, when other grass and green crops are ready to take the stock. The water is then turned on again, and the second crop is mown for hay about the latter end of June or beginning of July. The water is turned on a third time, and the aftermath which succeeds is fed off, which generally lasts until towards Christmas. The other grass land is alternately mown and grazed, except the cow pastures, which are always fed with the dairy cows.

There has been a considerable quantity of poor grass land brought into tillage within these ten years, and much more of it would be thus more profitably employed under a good system of tillage.

The Cotswolds.

Our second subdivision comprises the great oolite, fuller's-earth, Stonesfield slate, and the inferior oolite. The situation of the great oolite, or Bath freestone, will be indicated by enumerating some of the parishes contained within its limits. Bourton-on-the-Hill, the Swells, Bourton-on-the-Water, Hampnett, Yanworth, Rendcombe, &c., Daglingworth, Coates, Minchinhampton, Marshfield, &c.

The soil on the great oolite is a reddish brown, locally named *stonebrash*. Its quality varies. Part is a moderately deep loam; but the greatest portion is very thin, weak land. That which is nearest the rock is not always the *worst* land. There are many patches of a deep, loose, foxy soil, apparently a good, deep loam in the eyes of strangers, which is in reality very inferior. A tolerably sure criterion of the best land is when the stones amongst the soil are moderately large and hard. Where the stones are small and soft, the land is not so good for corn, but will bear moderate crops of turnips. The land which is most deceiving to strangers is where there is some depth of apparently good soil, free from stones, and very mellow to work. It is called *downsy* land, we suppose from the fact of our forefathers keeping it in downs for their flocks, in preference to tillage.

Nearly the whole of the downs is now broken up, and produces moderate crops, with paring and burning, and a liberal use of artificial manures. On this land the turnip-crop is uncertain, and all the cultivation and manuring of the best of our farmers have not, at times, been attended with success; but, on the contrary, sometimes the crop is a total failure. I have heard it remarked that in no other country are there so many failures in the turnip-field as across the Cotswold Hills. The failure is to be attributed principally to this description of land. It is found not only in considerable tracts together, but there are spots and veins of it running across fields of quite a different texture to the other portions. Whether it is merely the mechanical division of the soil that is at fault, or whether some essential ingredients are deficient, has not yet been proved by analysis; but certain it is that bone-dust has often been more beneficial than a dressing of farm-yard manure.

None of the great oolitic rock requires to be drained; the fissures of the rock, and the porous nature of the soil, readily allow any superfluous moisture to escape. The want of water is oftener felt to be injurious than an excess of it. The system of farming generally adopted is the five-field, setting aside a portion of the thinnest land for sainfoin, to the extent of about 12 or 15 acres in each 100, breaking up a portion every two or three years. and replacing it with a like quantity newly laid down.

Usual Rotation.

1st year. Turnips and swedes.
2nd ,, Barley.
3rd ,, Seeds mown for hay.
4th ,, Ditto, fed.
5th ,, Wheat, drilled generally.

And some still continue the six-field course, by taking oats after the wheat-crop, which is objectionable. If Rudge, 35 years ago, could see reasons for deprecating the sowing of oats after wheat, the objection comes with tenfold force in *our* days of agricultural improvement. On some of the best land the four-course is practised, and wheat taken after one year's seeds, and a double green crop, by growing vetches for sheep-feed before planting turnips. Many other variations of the above mode of cropping are adopted.

The Stonesfield slate and fuller's-earth, lying between the great and inferior oolite, form a narrow belt, running through the eastern part of the county, from Condicote on the north-east, through the parishes of Naunton (where there are good slate-quarries), Ashton Blank, Notgrove, Withington, Chedworth, Colesbourne, to Saperton, where the Stonesfield slate is excavated from the canal and railway tunnels.

It appears on the surface in a small band only, on the sides of the hills in Sapperton valley. It then winds round the north-west edge of the hills to Minchinhampton, and thence in a very irregular manner to the neighbourhood of Bath, &c. This insignificant band of clay gives rise to the rivulets on which the Gloucestershire cloth-mills and dyeing establishments are erected, and the waters are represented as being peculiarly fitted for the purpose of such manufacturers. The soil partakes of the character of the Forest marble and the Bradford clay, having a thin slate rock intermixed with clay, which causes it to be springy and very wet. There are not any farms wholly of this kind of soil. Where it occurs the crops vary a little according to the nature of each particular field, and it causes but little difference in the farming.

Immediately to the west of this worthless band of wet clay lies the inferior oolite, which brings us in contact with the eastern verge of the vale, at a point not less than three-fourths of the way up the hill. The character of the soil is much the same as that on the Bath freestone. The land is more elevated, the soil is weaker in quality, and the pastures produce but a scanty crop. In the valleys the soil is deeper, and the crops moderately good. The five or six field system of husbandry is followed, as on the great oolite, with about the same proportion of sainfoin. Analysis would probably show very little difference in the great and inferior oolites. The inferior possesses a trifle more silicious sand or less clay. It is not quite so adhesive when ploughed.

The size of the farms on this second division varies from 200 to 1000 acres and upwards. I know several above 1000; one or two above 2000 acres. Opportunity is thus given for men with large as well as small capital to embark in business. The smaller holdings predominate in the southern part of the district on the strongest land, and the larger on the middle and northern parts.

The peculiar character of the soil, and the management of the Cotswolds, will in some measure have been gathered from the previous remarks. It will have been seen that the land varies much in quality, still retaining the same outward character, being calcareous or marly. It is nearly or altogether free from silicious matter in the shape of flints, and, in comparison with other soils, contains a very moderate quantity of sand. It is naturally of a hollow, porous character, contracting and expanding with almost every alteration in the weather. We do not therefore plough even our wet lands into the narrow stetches for the cattle to walk between whilst planting it, as is the practice in the eastern counties. On the contrary, we find that the treading of teams is beneficial in wheat planting, provided the land is not so wet that their footsteps will not harrow out. Late-planted wheat and vetches are liable to be drawn out of the ground and get very

thin in plant, from alternate frosts and thaws during the winter. This was the case last season. The frost set in earlier than usual and continued severe longer, which left the wheat plant thin.

I cannot better draw a comparison between the calcareous soils of this district, which are called light, and the silicious soils of other counties, which are also termed light, than by supposing a heap of slaked lime to represent one, and a heap of sand the other. One would be light and hollow, the other close and heavy. The specific gravity of the calcareous soil is lower than is desirable; it therefore requires pressure and consolidation to enable the roots of plants to retain a firm hold on the land. The specific gravity of the silicious is greater than is desirable, and claims all the skill of the farmer to keep it hollow and porous, to admit the air and allow the roots to spread in search of food. This may in some degree explain the reason why a sand-land farmer would not succeed on the Cotswolds, unless he adopted some of the practices which are peculiar to the district.

Roots.—Having digressed for a moment, to explain the peculiarity of the soil of this district, I will proceed to the management of the usual crops; and first, as to the different modes for swedes, turnips, and other roots. Roots usually succeed wheat—oats, one or two years seeds—old sainfoin lay, or rye and vetches, fed off by sheep the same year. After harvest, as soon as the wheat stubbles are cleared, and other work will allow, the land is ploughed moderately deep, to remain through the winter. It is generally ploughed again in April, when the weather is dry. It is then scarified and cleaned. Some use the scarifier without previously ploughing, which will answer on the dry, but not so well on the clayey souls. Clay soils do not often get sufficiently dry early enough in the spring to allow of the use of the scarifier to the best advantage. It is the practice with some to put on the farm-yard manure in autumn, previously to ploughing up the land against winter. Others only breast-plough the manure in, leaving it through the winter, and horse-plough the land in the spring. This is found to answer well, for two or three reasons: the manure gets mixed up with the soil, which is not rendered so hollow as when the manure is put on immediately before planting. By adopting this plan we lessen the work to be performed at the most busy time of the year. The manure being in the soil in autumn gives more time for decomposition to take place, and is in consequence more available for the use of the turnip-crop during its early and most dangerous stages of growth. The manure is often ploughed out in the following spring, to all appearance, almost as fresh as when first put on the land, only a little drier; which indicates that the soil is a slow decomposer of manure and vegetable substances. Manuring against winter

must of necessity be limited, as the bulk of the manure used for turnips is not then made. Manure is usually carted from the yards to the field in winter, and placed in large heaps. The heaps are turned twice over previously to putting on the land, and are in most instances covered with earth. When the land is properly cleaned by scarifying, harrowing, collecting and burning the weeds, the manure is applied, either in ridges, or what is the most general way, spread on the surface and lightly ploughed in. Some plant their swedes on the ridge, and obtain good crops. Others, having tried it, prefer drilling on the flat, *being more sure of a plant.* When drilled on the flat they stand the dry weather better ; still there is no doubt but the heaviest crops are grown on the ridge when the soil is properly pulverized. Common turnips are rarely planted on the ridge. The artificial manures mostly used in this district are bones and sulphuric acid, and guano ; the latter being sown broadcast, and ploughed or harrowed in, before the seed is sown. The bones are mixed with ashes and drilled with the seed. Ashes obtained by burning old banks or digging from the road sides and other places, have often been drilled alone. From two to four pounds of seed per acre are drilled. The usual quantity is four pounds, but many ardently advocate the use of a less quantity of seed. The sorts are also rather numerous. One kind may, however, be mentioned, on account of its being, in some degree, peculiar to the county. It is a *white* swede, rather coarse, but a very hardy variety, and considered better for ewes and lambs in the spring than the yellow swede. Some of the farmers near Northleach, where, we believe, it originated, *plant no other ;* observing, that it grows *more rapidly* on their *poor* land than any other. I have stated that it is usual to clean and plough up wheat stubbles in the autumn, but sometimes the foulest of the wheat and oat stubbles are left to be breast-ploughed and burnt in March and April. If the weather be dry and favourable for burning in those months, the land can be cleaned tolerably well with one or two-horse ploughings afterwards. If wet, I have occasionally observed the cleaning of the land to be out of the question, and have seen the turnips planted amongst the couch and weeds ; and, what will appear surprising, I have sometimes seen good crops thus obtained, better than on land that had been drilled, with the land in much cleaner condition. A few farmers pare and burn their old seeds for wheat, and reserve about 80 bushels per acre of the ashes in the fields, in heaps which are thatched and remain to be drilled with the turnips the next season ; being mixed with bones at the time when they are drilled. Parties who have tried this method have told me that their turnips had been better where the seeds had been burnt, before sowing with wheat, than where burning had not been resorted to ; other management being the same on both.

The preparation of the land in old sainfoin and seeds is, to commence paring the sainfoin (this, having the strongest sward, is not so liable to be lost as younger seeds would be if ploughed too early) in January or February, following on with the seeds and stubbles. It is considered important to burn as much as possible for the turnip crop; some, therefore, rist-baulk or half-plough their sainfoin ley. In a month or so the breast-ploughers follow and pare off the furrow that is left, or it is sometimes torn off by the scarifier, taken across the baulks. A large quantity of sods to burn is thus procured, and a good coat of ashes the result, which are almost sure to produce a good crop of turnips without any other dressing. After the ashes are spread the land is again rist-baulked or ploughed clean, very light, well dragged and harrowed; and, if time will permit, the land is again ploughed as shallow as possible. When seeds are followed by turnips the land is breast-ploughed and the sods burnt. If the land is free from couch-grass, &c., as it ought to be, the ashes are spread and one light ploughing performed, which is often sufficient. Should manure be applied, it will be ploughed in with the ashes, but it is not often that manure can be spared for the purpose. The land is then rolled down and harrowed. I have found the Norwegian harrow superior to any other implement for this purpose. It pulverizes the furrow without pulling it out of place. The land is then again rolled down, and the seed drilled with some of the ashes. Some think that sowing broadcast is best after burning, observing that the turnips will find out where the ashes are abundant better than when drilled, and consequently grow away faster at first, but the seed may in fact be better supplied with ashes if both are drilled together.

Turnip-hoeing is generally done by the acre. From 2*s.* 6*d.* to 3*s.* 6*d.* is given for singling out on the ridge, and from 7*s.* 6*d.* to 12*s.* for hoeing twice over, drilled on the flat or sown broadcast: but Gloucestershire is not celebrated for good turnip-hoeing. It is worthy of remark that hoeing turnips on the Cotswolds sometimes apparently *does mischief.* The best piece of turnips that I witnessed in my excursions over the county last autumn had not (in November) been hoed at all. I also observed that those who cultivated the best and hoed the most, lost their entire crop by grub and wireworm. The anomaly here mentioned is by no means unusual on the dead soil of the Cotswolds.

Mangold and carrots are not planted to any great extent in these districts, but the quantity of mangold is increasing every year. It is found a more *certain* crop than turnips are in dry seasons. Mangold is either drilled or dibbled, with 4 or 5 lbs. of seed per acre. Farm-yard manure is always applied. The

season for planting is at the latter end of April and beginning of May.

Barley and Oats.—The root crop is generally succeeded by barley, but oats occasionally take the place of barley. After the turnips are consumed the land is ploughed up the usual depth of 3 or 4 inches, in February March, and April. As the spring advances the fold is closely followed by the plough, and to prevent harshness the breast-plough is called into requisition. The surface is turned over an inch or two thick, burying the sheep's dung, &c. *This prevents loss of manure by evaporation,* and keeps the soil moist. Barley is almost all of it drilled. The time of planting extends from the end of March to the beginning of May. Many prefer early sowing, but I think it is desirable to be more particular *how* it is planted than as to the time *when.* If the land be worked when too wet underneath, the barley, however well it may come up, will be sure to indicate that all is not right before harvest. The land is seldom dry enough before April, when the greatest portion is planted. From 2 to 3 bushels are drilled, and 3½ to 4 bushels are sown broadcast. Where land is *very subject to charlock* there is great danger of injuring the barley crop by sowing too early. I have found great benefit from having the land ploughed as soon as possible, and allowing it to lie until the charlock came up: I then work it well and drill the barley. In about ten days afterwards, just before the barley appears, we sow the seeds, and give it a double tine with some light harrows. *This will kill nearly the whole of the charlock.* Perhaps the barley may suffer a little in quality, but that loss is trifling compared with having it full of charlock. The average crop of barley is about 4 quarters. Barley is mown at from 1*s.* 8*d.* to 2*s.* per acre, and harvested loose in the same manner as hay.

Oats.—Those who still continue the six-field system plant oats after the wheat crop, often breast-ploughing the wheat stubble before Christmas. They then harrow out the parts of the couch and grass cut off by the breast-plough, and burn them or haul them off as the weather permits. The land receives one plough in the spring, and the oats drilled or sown 4 to 5 bushels to the acre in March. With this crop the sainfoin is generally sown: seed about 4 bushels per acre. The produce of the oat crop is from 4 to 5 quarters per acre.

Seeds.—A mixture of about 1 bushel of rye-grass, 5 lbs. cow-grass, 4 lbs. trefoil, and 3 lbs. white Dutch, is sown with barley and oats. The crop is usually called " Seeds," which is mown the first year for hay. It is a general rule to mow the seeds at the latter end of May and the beginning of June, following on with the sainfoin and meadow grass immediately after. It is not

usual to spread seed hay or sainfoin about like the meadow grass. It is turned once a day in swath for a few days, and then put up in small wads, doubling them in size as it approaches hay. When sufficiently made or *won* it is stacked at once in the rick, some of it very often in the middle of the turnip-field. When seeds are a tolerably heavy crop, some farmers are so particular as not to turn the swath with rakes, but with forks only, which keeps it more open and hollow (the rakes, getting it too much like a rope, prevent its making so fast). The English or meadow grass is tedded or spread immediately after the mowers, and at night put up in a small foot-cock. It is afterwards spread about every fine day and taken up every evening until made into hay, when it is carried to the stack-yard and ricked. Hay never cuts out so well as when it has been stacked from the field as fast as made. We do not much practise putting it in small ricks or large cocks in the field for a time previously to being made into permanent ricks.

Whatever branches of farming Gloucestershire may be considered behind in, there is no doubt it is ahead of most counties in the art of haymaking. Certainly the farmers beat their northern brethren. Our northern friends come into the south and condemn our efforts at growing turnips; we plead peculiarity of climate and soil. We occasionally stray into the north, and instead of finding hayricks we thrust our hands into ricks of seed. The Gloucestershire farmer would thrash such hay as I have seen in Northumberland and elsewhere. I am puzzled to find an excuse for them, unless it is forgetfulness. Their minds must be so intensely absorbed in the study of the means of producing large crops of roots, as to forget that they have any grass growing. This may, in some measure, *explain the outcry raised against the use of hay that has lately become so fashionable.* Much of the hay they make *is little better than straw.* Our average crop of seed and clover hay probably does not exceed 1 ton per acre. The quantity varies from 12 cwt. to 2 tons. The aftermath is fed with sheep and young cattle together, and if not broken up for wheat at one year, the land is stocked as before, and fed the next year until July or August, which is the usual time to begin ploughing for wheat.

Sainfoin.—Sainfoin is grown by most farmers on the Cotswolds, and on the elevated calcareous soils is a very useful plant. It should be sown early in the spring, after turnips when the land is in good order, amongst barley or oats, or wheat when the land is in good heart. The usual quantity of seed sown is 4 bushels, and often in addition about 4 lbs. of milled hop or cow-grass, or a mixture of both. The price of sainfoin seed is generally from 4*s*. to 6*s*. per bushel.

Sainfoin should not be fed much in the autumn, immediately after being sown, and not very often the first year; the usual practice being to seed the first crop, and sometimes to mow it for hay. It should be mown for hay as soon as it begins to flower. The earlier it is cut the more valuable the hay, and the better the aftermath. When mown it is left in swath for two or three days, and then turned over, and at the end of other two or three days turned again. It takes a long time to dry, yet ought not to be moved about much; still it requires to be made dry or it will heat, and if it gets heated much it is spoiled. When a very thick crop, it is occasionally *tedded* and put up in small *wisps* and left for two or three days, and then made into *button* or small cock; after which, in two or three days, it is fit to carry. The aftermath should not be turned in upon, as is the custom on old grass-land in Gloucestershire, immediately after the hay is off. It should be reserved to wean lambs upon, being the best crop grown for the purpose. After the lambs have settled down to their pasture, young stock of any kind may be turned into the field. Sheep and lambs are apt to have the scour on grass and seeds, and it often proves fatal. A change of pasture is reckoned a good thing, but the best remedy I know is to turn them into a field of sainfoin aftermath. It invariably stops the scour, and I have known it do so *when nothing else would.*

Sainfoin hay is sometimes stacked in the turnip-fields to be consumed by sheep while eating off the turnips; it is often cut into chaff, placed in cribs, and given to the ewes in yeaning season. The hay when cut early, as it ought to be, is very good, and relished and eaten by all kinds of stock; but I have seen it neglected and all but run to seed before being cut, which very materially injures it. The stems become woody and the leaves drop off. After remaining down five, six, or seven years, it becomes what is termed "*old sainfoin ley*," which is usually broken up again in February by being breast-ploughed and burnt and succeeded by turnips, or rist-baulk ploughed and burnt, and afterwards cultivated and sown with turnips.

Wheat.—When the preparation for wheat commences, a skim coulter is fixed to the plough for the purpose of burying the turf as much as possible. A stale furrow being best for wheat, the longer in season it is ploughed before planting the better and firmer the land is for the purpose. Wheat is not planted so early as it was in the time of Rudge. *We do not plant so early as July.* The middle of September is considered soon enough to begin. It is usually sown earlier on weak lands and in very exposed situations. Drilling with the Suffolk drill is the general mode of planting, but broadcast is not wholly extinct. Dibbling has lately been tried by several farmers with Newberry's dibbling-

machine, but it is very questionable whether dibbling will supersede the drill to any extent. The dibbling-machine does not deposit the seed so regularly as the drill. I have counted from eight to seventeen plants in a bunch, and nearly adjoining each other, and the machine will not work with the land in so wet a state as the drill will. I, therefore, deem it not so suitable for late planting. The greatest advantage in dibbling is on the lighter kinds of land, where early planting is practised. It confers a greater solidity on porous soils than drilling, but consolidation can now be obtained by the numerous implements made for the purpose, as well as by the old practice of driving stock over the land, which is still followed to some extent. Two bushels of seed are usually sown per acre, but some are trying a smaller quantity. I have tried one bushel drilled rather early, on poor land, with advantage, although this kind of land is not generally considered suitable for thin seeding. Red wheat is much the most commonly grown, and the old red straw Lammas the favourite. Many other sorts have been tried, Golden Drop, Clovers Red, Spaldings, &c. Several of the new sorts will, at first, grow more in quantity than the old, but the quality is complained of by the millers. The wheat growing on the best land, in this district, is generally hoed at 3*s.* to 4*s.* per acre. Some is weeded and thistles removed by women with paddles, and many fields are not touched from the time of planting until harvest. Reaping with the common sickle is the usual way of cutting nearly all the wheat, which is performed by men, women, and children, from the neighbouring villages and towns; many small tradesmen leaving their calling to take a share in it. Mowing has been introduced, but does not rapidly gain favour in the eyes of the farmers. The practice of bagging or fagging is increasing in favour. The greatest drawback to both mowing and bagging is the increased quantity of straw that has to pass through the machine. Thrashing is mostly done by horse power, and if little or no expense be avoided by mowing or bagging, the saving of horseflesh is worthy of consideration. The cost of cutting in either way is from 6*s.* to 10*s.* per acre. The produce varies very much with seasons. It has been estimated by several farmers at an average of 22 bushels per acre for the whole district. Prizes have been offered through the Cirencester Society for dibbling wheat with small quantities per acre, ranging from one peck to three or four, from which no satisfactory results were obtained. The crops were all but a failure, and the prizes were discontinued. Mr. Edward Bowly tried several experiments with thin drilling, which, it appears, did not answer, as we find he does not follow the practice. Gloucestershire cannot be said to be a thick-seeding county. From six to eight pecks is the usual quantity of wheat.

Live Stock.—There are not extensive herds of cattle kept on the Cotswolds, it being principally a sheep country. We have some breeders of short-horns and Herefords. Amongst the former Lord Sherborne, Mr. Bowly, and Mr. Garne of Sherborne, hold a prominent place; and Messrs. Hewers and Nicholls as breeders of Herefords. The Herefords are liked best for steers and working oxen, and the short-horns as heifers to sell for the dairy. Most farmers keep from six to twelve or fifteen cows, but besides rearing their own calves a great many are bought annually from the dairymen of North Wilts, so that a much greater number is weaned and reared than the number of cows kept. Young beasts graze through the summer with the sheep flock on the second year's seeds and aftermath of the young seeds and sainfoin, and are afterwards put in the yards to hay and straw. Sometimes a few turnips are given them with the straw, but this is not a general practice. The heifers are sold in calf to the dairymen at three years old, and the steers are broken into work to supply the place of older oxen that have been sold off to the grazier. A considerable number of oxen are worked in the spring and summer months, which are turned into the straw-yard in the winter. Four, and sometimes five, are used in a team at length, and six or eight in a team are yoked double to the drags, working in harness like horses. When they begin work in the spring their food consists of hay or chaff, with barley-meal; and in the summer they are turned upon the seeds and rough pastures. They are considered to be less expensive to keep, and more certain of increasing in value than horses, and can be put aside with advantage at certain times in the year, when the work at which they are usually employed is done. Hence the benefit of working both oxen and horses. Very few cattle are fatted in summer, or in yards or sheds in the winter, except by those who hold grass land in the valleys of the Windrush, and a few other small grazing spots interspersed about the district.

Sheep.—Sheep, the principal stock of the Cotswold farmer, occupy the greatest share of his attention. The Cotswold sheep of the present day are the improved Cotswold and the new Leicester. In the time of Rudge serious attempts were made to improve the breed of sheep, and numerous crosses obtained, which, after discussion amongst breeders, ended in producing the sheep so well known to the visitors of the annual meetings of your Society as the winners of all the prizes in the long-woolled class. Our sheep are in great demand in all parts of England, as well as Ireland, for crossing with other breeds. Great pains have been taken to improve our sheep by many spirited breeders, and they have been well repaid for their trouble. The prices given for their tups, however, have not reached those realized for the best Southdowns and Leicesters. This I cannot attribute

altogether to fancy. It may partly arise from want of real merit in comparison with them. We dare not boast even of our flocks, because there is danger in thinking we have reached perfection in any point of husbandry, and more especially in breeding.

After animals have attained the extraordinary aptitude to lay on fat, which we witness at the present day, it may reasonably remain a matter of surprise that this quality should *now* be considered at our shows almost the only thing needful.

The ewes begin to drop their lambs at the beginning of March, at which time they are taken home to the lambing-yard. They usually have access to a grass field, where they have a few turnips served in the daytime. When the lambs get sufficiently strong the sheep are removed to the turnip-field, which would serve them until the second year's seeds afford a good bite. Sometimes a temporary pen is made in the turnip-field for the ewes to yean in, surrounded with little houses made with hurdles to put each ewe and lamb in, until the lambs are a day or two old. Some of the best hay is given to the ewes at this period. It is this season, when green food and turnips sometimes run short, which renders good hay so valuable in producing milk for the lambs. When the turnips are consumed they are turned into the second year's seeds, where they remain until July, when the lambs are weaned, and put into aftermath of seeds and sainfoin. The wether tegs and ram tegs, if any, are put on the vetches, to be forced on for the annual tup sales in July and August. It is the rule to put about sixty ewes to one tup, each flock having separate fields. Towards Michaelmas the lambs are put on the turnips, the wether lambs being more particularly attended to, having cut turnips and swedes with hay. Some farmers give them corn and cake also, *but many fat tegs, weighing from* 20 *to* 30 *lbs. per quarter, are brought to the neighbouring fairs in April and May, being from thirteen to fifteen months old, that have had neither cake nor corn.* Those which are not fatted the first winter on turnips are fed the following summer, or sold in store condition, *but few are kept to be two years old.* The draft ewes, if not fed, are sold at the fairs in August and September. Their wool is rather coarse and heavy, preference being given to quantity rather than quality. The clip of ewes will average about 6 lbs., and that of the tegs 7 lbs. each.

The stock kept on farms varies according to the quality of the land, or with the system of management. The average number of sheep kept on the best farms will run to about a sheep to an acre, some rather more, but on thin elevated soils not so many. See Statistical Table at page 144.

Pigs.—The pigs are mostly of the Berkshire breed. The colour is nearly black, and spotted with patches varying in shade a little from the rest of the body.

Statistical Table.

Return.	Locality of Farm.	Arable acres.	Pasture acres.	Number of Sheep kept.	Number of Cows kept.	Number of Working Oxen.	Number of other Horned Stock.	Number of Cart Horses.	Number of Men.	Number of Women.	Number of Boys.
No. 1	Vale of Thames	450	350	1,000	16	16, and 2 bulls.	66	8	24	..	8
,, 2	Do.	300	180	600	20	12	..	7	14	12	7
,, 3	Do.	471	240	700	28	8 to 10	62	15	20	12 to 14	8
,, 4	Do.	413	132	400 to 900	4	None.	Not stated, but we know upwards of 40.	20	26	6	8
,, 5	Do.	208	37	370	24	..	..	11	12	4	3
,, 6	Do.	180	75	280	16	..	24	7	10	7	2
,, 7	Cotswolds	470	300	650	8	20	Not stated, but we know upwards of 30.	10	20 to 30	14	8
,, 8	Do.	103	17	120 to 140	3	Some for feeding.	..	5	4	Uncertain	4
,, 9	Do.	144	39	350	..	..	Not stated, but we know more than 20.	6	7	3	..
,, 10	Do.	175	110	400	4	None.	20	6	10; more in summer.	2	..
,, 11	Do.	360	15	Yeans 120 ewes.	..	Keeps but few.	..	10	10	Uncertain	7
,, 12	Do.	397	33	494	6	Not stated, but we know of 8 or 10 oxen.	..	12	19	6 to 12	5
,, 13	Do.	320	30	Yeans 170 ewes.	..	6 or 7	Not stated; we know of several	9	12	10	5
,, 14	Do.	1,051	112	1,000	2	30 to 40, and other beasts.	..	17	34; in sum. 8 or 10 more.	6 in winter 12 in summer	16
,, 15	The Vale, Evesham	400	100	440 to 650	40	..	..	18	27 m. & boys	5	..
,, 16	Do.	126	199	300	80 to 90	..	..	11	10	6 to 10	4
,, 17	Do.	150	200	300 to 350	90	25 beasts, and rears 20 calves.	..	12 to 14	12	8	4
,, 18	Do., Gloucester	218	63	Yeans 220 ewes.	..	27 fat oxen.	..	7	7	8	1
,, 19	Do.	120	140	100	12 to 16	10	..	8	9	3	..
,, 20	Do.	103	97	300	2	..	..	6	10	8 to 12	3
,, 21	Do.	210	570	800 to 1,000	50 to 100	50 to 100	..	24	22; sometimes 40 to 50	11	..
,, 22	Do., Berkeley	70	502	200	30	80 to 90 fatted.	..	5	A great	many.	
,, 23	Do., Bristol	150	110	100	15	..	..	8	10	3	..
,, 24	Do.	58	160	50	30	..	..	6	10	3	2
,, 25	Do.	145	160	Yeans 120 ewes.	12	40 of all ages.	..	10	10	10 to 12	..
,, 26	Do., Forest	38	67	170	2	Number not stated.	4	3	3	..	1
,, 27	Do.	120	111	50	30	Not stated.	..	10	9	4	..

Horses.—The horses in general use amongst the farmers are the native blacks. They are not very large, and have become more active and cleaner in the leg from having been crossed with the Flanders for several years past. The Suffolk breed has been introduced by many gentlemen into the county, but the use of these animals does not appear to have extended so rapidly as their merits deserve.

Within the last twenty years much of the land on the Cotswolds has been ploughed with two horses only. A considerable portion is comparatively easy to plough, but on the eastern boundary, and particularly on the Forest-marble and Bradford clays, it is very hard work. A pair of horses only have always been used on the College Farm at plough, but the pair of horses of theirs have cost more to keep them up than three of the horses of the neighbouring farmers.

The Vale.

Evesham, Gloucester, and Berkeley.—Our third agricultural division of the county comprises the vales of Gloucester, Berkeley, and Evesham, the farming practised in which we are now called upon briefly to describe. The soil in this division varies very considerably. Here we find a small portion of very superior land of a sandy loam, called drift by geologists. This description of land, being foreign to the general character of the district, is only to be met with in detached portions, as at Frampton-on-Severn, Haresfield, Whitcombe, around the town of Cheltenham, at Shurdington, Uckington, Common Fields, &c. This soil produces large crops of turnips, wurzel, carrots, and all other root and green crops, alternately with wheat, for many years together, under the management of its best farmers, feeding sheep and cattle, both in the sheds and in the field. What is practised on farms composed of such land is no criterion for the farmers on the lias clay, the prevailing soil of the district. This clay forms the soil as well as subsoil in many places. It is sufficiently calcareous not to require liming. The soil is not of that hollow kind which is characteristic of the Cotswolds, and scours from the plough and other implements much better. It is ploughed much deeper and requires more strength, which is in some measure attributable to its being ploughed in such high lands or ridges, especially when being gathered up towards their tops, causing so much more friction against the hard furrow. Few farms have an uniform soil; some fields being rather sandy,

others of a tenacious unmanageable clay. From draining, a long continuance of good farming, and the addition of coal-ashes, soil, and refuse from the neighbouring towns, some lands in some degree have changed their nature, and are become more friable, and are easier managed. The naturally worst portions are badly managed by reason of being wet, poor, and a very stiff clay. There is not the least doubt, from what we have seen accomplished already, that the Vale farmer has a safe foundation to work upon in attempting to improve the whole of the lias formation. It is naturally superior to the Oxford clay district, which has in many places been so much improved by stifle burning. A portion of the Vale is situated on the red marl and new red-sand. Where they join the lias the line of division is very plain from the different colours of the soil. The red-sandstone, as its name imports, is a red description of land, and its most clayey or marly parts contain some sand. Lime is beneficial on this land when not intermixed with the lias. There is a great difference observed in the structure of these soils. In a field of stiff soil we picked up a clod from one side of the field which was lias. It was finely laminated, and continued to cleave asunder into as many minute rectangular fragments as we chose to break it into, showing between every fragment a shining unctuous matter by which the laminæ were held together. The clod from the other side of the field from off the red marl broke to pieces without showing the least joint or laminated structure. These I consider the characteristics of calcareous and silicious soils. On questioning the occupier as to the relative value of those soils, he thought the red land the best in quality, but the most uncertain from its liability to run and cake together after heavy rains, saying that he would rather have the lias, which, from appearance was not worth so much by 10*s.* per acre.

The farming in this division differs greatly in many respects from those of the other portions of the county. The soil is generally of a tenacious character, though in many places a deposit of diluvial sand and gravel has greatly modified the natural character.

The Vale farmer becomes in some degree a manufacturer. We find him converting his milk into butter and cheese, and in possession of orchards of apple and pear-trees, from the produce of which he manufactures cider and perry. The farms are small compared with those on the hills, rarely exceeding 300 acres, the great majority scarcely reaching 150. The soil being tenacious, few farmers winter flocks of sheep except on the diluvial soils.

The exact proportions of grass and arable land cannot be accurately stated, but I believe them to be about equal. The

grass portion is much the most valuable, containing the meadows of the Severn, Avon, Chelt, and other small rivulets, which form the best land, besides a considerable quantity of first-rate upland pasture. There are several dairies in the vales of Gloucester and Evesham, but the principal portion of the grass land is applied to rearing and grazing in connexion with them. This is in some measure to be attributed to the inferior quality of the cheese and the difficulty in making it. This appears singular, because much of the land is excellent feeding land. There are but few cattle or sheep bred in this district. The graziers depend on Gloucester and the neighbouring markets for the supply of store-stock, and on the towns in the neighbourhood and the manufacturing districts of the north for a sale when fat. The vale of Berkeley still retains its fame for its dairies, and the grass land for the production of excellent cheese, although the breed of cows is totally changed. In the time of Rudge the Gloucester and long-horned beasts were the principal stock, which have almost disappeared, and are replaced by the short-horns. There are some of the old sort left, but the farmers who still retain them are rather fond of a cross, and indeed many farmers speak favourably of a cross between the short-horn and the Hereford. Mr. Ireland, a farmer near Tewkesbury, considers the stock obtained from this cross the best for all purposes. The entire change of stock in the Berkeley Vale not having also changed the quality of the cheese, shows that the quality depends on the land, however the quantity may be affected by the change of stock. The general system is still either the 4 or 8-course, that is three crops and a fallow, although, where the land has been drained, a bare summer's fallow is not so frequent as formerly, A fallow crop is now taken of vetches or trefoil, to be eaten off by sheep, and the land afterwards *bastard fallowed* :—

1st year.	Summer fallow or vetches and bastard fallowed.	5th year.	Fallow.
2nd ,,	Barley.	6th ,,	Barley.
3rd ,,	Beans.	7th ,,	Clover.
4th ,,	Wheat.	8th ,,	Wheat.

On land that has been drained, and is rather inclined to a sandy loam, swedes, turnips, carrots, and mangold have been introduced. Those crops are sown on a portion of the fallow quarter, and in favourable seasons heavy crops are produced. The greater part is generally hauled home to assist in feeding the cattle in the stalls. The root-crops are seldom fed off on the land, the practice being thought injurious, though some few instances have come under my observation. A particularly heavy crop of swedes was fed off on the land during the winter, on a farm in the parish of Boddington, adjoining the road from

Cheltenham to Tewkesbury. The sheep were folded and had hay and corn the same as on the hills, and did well and got fat, and the land grew a fair crop of barley afterwards. This was done by a farmer *who a few years previously considered it poison to the sheep and to his land* to allow them to come on it in the winter. He continues the practice. This would introduce another course of cropping for the sandy portion of the lias clay :—

1st year.	Fallow with turnips.	5th year.	Fallow with vetches.
2nd ,,	Barley.	6th ,,	Wheat.
3rd ,,	Clover.	7th ,,	Beans.
4th ,,	Wheat.	8th ,,	Wheat.

On the stiffest clays and worst-farmed land there are scarcely any vetches planted for sheep, and but few roots. The three-crop and fallow is continued with the land anything but clean. In wet seasons with the land undrained it is impossible to clean it as could be desired.

Fallows.—When a portion of the land in fallow is sown with vetches for feed, it is ploughed immediately after harvest, and from 2 to 3 bushels per acre are sown or drilled as soon as the state of the land will permit. It is important to get them in as early as possible, in order that they may be fed off early in June, to enable the farmer to plough, scarify, and clean the land for wheat before the busy time of harvest. That part which is intended for roots is also ploughed as early as possible, and if the state of the weather is likely to allow of partially cleaning the land before winter, it is not ploughed very deep, because the couch is more easily forked out, and the drags work with more effect when not too deeply ploughed. It receives a deeper furrow afterwards, and is laid up through the winter. The manure is applied either in frosty weather or as early as possible in the spring. The land is again ploughed, and the swedes are then drilled, sometimes as early as April, but more generally in May. The land which is intended to have a bare summer fallow does not often receive its first ploughing until spring. It is left until the bean land is all ploughed and spring planting finished. When no crop is intended to be planted, it is considered preferable not to have it ploughed against winter. The frost would pulverize it and make it too fine and dusty. To make a good and clean summer fallow it should remain in large, rough, hard clods through the summer. When it has received the first furrow, and laid until it is tolerably dry, it is either ploughed back again, which is called turning the furrow, or it is ploughed askew, setting it as rough as possible. It is afterwards moved occasionally with the scarifier, with the view of well roasting it. Probably it may require one more ploughing to make a clean

job; but if the first ploughing be sufficiently deep and well executed, it will rarely require more than the use of the scarifier to fully clean and put it into a healthy condition for the course. If the summer be dry, this condition will be sure to be obtained; but if wet, a *rough* fallow is more likely to be cleaned than it would be if in a finely divided state. Much more soil would be exposed to the action of the air, and the evaporation from it would be greater. Where the land is undrained in very wet summers, it is almost impossible to clean it by the usual methods adopted. Towards the end of the summer the manure is applied and ploughed in to remain until the wheat-planting season, or through the winter in cases where the land is intended for barley. The plough in general use for common work is a very long wooden swing plough, which is drawn with three, four, five, and sometimes six horses at length. The most general team is four or five; but I have often seen six horses and two drivers.

Barley.—The land which has been fallowed for barley and left during winter, receives one ploughing in the spring, and is then drilled, as early as the season will permit, with about 4 bushels per acre. The produce varies from 3 to 8 quarters per acre, depending very much on the season. The barley of the Vale is generally of a good malting quality, and is preferred to that of the Cotswolds.

Clover and Beans.—One-half of the barley land is sown with broad clover and trefoil mixed, at the rate of 12 to 14 lbs. of the former to 4 or 5 lbs. of the latter per acre. The first crop is mown for hay, the second sometimes left for seed, and sometimes cut for hay. The farmers not keeping very large flocks of sheep, the clover is seldom fed off. A portion is mown and carried home for the cart-horses. In the northern part of the county and adjoining the county of Worcester, clover is fed off on the land by horses. The horses are tethered by the fore leg; their range being limited, hungry animals are compelled to make clean work. Clover grown for the purpose of seed is a very uncertain crop, sometimes scarcely worth the cost of thrashing, at other times the produce is from 3 to 5 bushels per acre. The thrashing and preparation for the market creates a good deal of labour, and is probably on an average more beneficial to the labourer than the grower, hence the adage "A seeding farmer never gets rich."

The land intended for beans is ploughed deep in the winter months. In general it is cast down; and in autumn, after the beans are off, it is ridged up for the succeeding crop of wheat. This is the season when *the long teams are seen moving almost imperceptibly along*, ploughing from half an acre to three-quarters a team per day of 7 hours, being at work from daylight to 3 o'clock in the afternoon. If the land be all ploughed by Christmas, it

is considered done in very good time. As soon in spring as the weather will permit, the beans are planted with a two-furrow drill, or by hand by women. Bean-setting is sometimes done by the acre; but the common custom is by the bushel. The usual prices are 1*s.* per bushel, or 4*s.* per acre. When planted or set, the quantity of seed is 4 bushels; but where drilled, is 4½ bushels per acre. Those generally planted are the large Gloucestershire beans. Some who prefer quantity to quality, plant the Berkshire and French. Beans are twice hand-hoed in the spring, at an expense of 7*s.* to 9*s.* per acre, according to the state and cleanness of the land. When ready to harvest, they are reaped or bagged, and tied up in sheaves, and stocked at a cost of 6*s.* to 9*s.* per acre. The produce of the bean crop, like that of barley, is uncertain. Sometimes an immense crop of straw is grown with but little corn. From 3 to 5 quarters per acre is the produce. It is considered that the bean crop little more than pays the expenses on an average; but it is esteemed useful as a preparation for the following wheat crop. The straw is also valuable as fodder for the horses, and for increasing the manure heap.

Wheat generally succeeds beans, clover, vetches fed off, and sometimes turnips and other roots. As soon as the beans are harvested, the land is what is termed "Bean-brushed," that is skim-ploughed or brushed over about 3 inches deep. It is then harrowed well, to clean it of couch or other weeds, which are picked up or gathered together with the bean stubble and burnt. If any manure is to be applied it is now put on, and the land ploughed again moderately deep, in which state it is ready for planting. The manure is not often applied to this crop, the land generally receives its manuring when fallowed. The clover ley is ploughed up as time will permit; it is better done early, to allow the furrow to get stale before planting the wheat. In general the land is first fit for planting after vetches and fallow, but it is advisable to plant when the seed will work in moderately firm. The turnip or root land is in general the last to be planted; it is ploughed and planted as opportunity offers up to Christmas, or even after; the spending and carting off requiring time. The principal part of the wheat is now drilled with three-furrow drills, which are made in the district. These machines will also drill beans by taking out the middle share. The Suffolk drill is also introducing itself, and when more of the land is drained and the immense deep and wide water-trenches removed, will be found to be an useful implement, especially if made purposely for stiff land. Two bushels per acre is about the average seeding of the drilled wheat. Half a bushel extra is added if sown broadcast, or drilled very late; there are instances of a less quantity having been tried with success. The kinds planted of both red and

white are more numerous now than formerly; some having a very short ear. The red wheats sown are the clover, Spalding, cone, Cobham, and the old red Lammas, which is still the favourite; and the white kinds sown are Smithies, Hopetown, Chidham, Essex, and Brown's 10-rowed prolific. There is more red than white wheat grown on this part of the Vale. In wet seasons the red wheats stand the winter better; but all kinds of wheat suffer from continued wet weather during winter and spring.

Reaping with the sickle is the general practice of the county. Where the crops are heavy the wheat is cut rather high, which leaves the stubble of sufficient length to be used for thatching the ricks; the cost per acre, according to the crop, is from 7*s.* to 10*s.*, sometimes 12*s.*, and four or five quarts of drink per day. Bagging is being introduced, but it is a work of time to expel one system and substitute another, even when it is known advantage would be gained by so doing; and the superiority of this method over reaping is rather questionable.

The produce varies exceedingly even on the land drained and well farmed, much more on that which lies as it were in a state of nature, for some question whether the high-ridged lands without underdraining are not in a worse state than if they had remained flat as nature left them. It has been remarked, that the farmers have been always trying to plough the land out of the water, instead of getting the water out of the land. The produce varies from 16 to 48 bushels, the latter being the produce of a small portion of the best land, which comprises not a fourth of the district. The general average is about 25 bushels per acre, taking the whole of the vale above Gloucester, a low average for a strong wheat-land district, proving that there must be much middling land farmed moderately, or good land farmed ill.

Teazles.—Teazles have been grown in this county probably as long as Gloucestershire has been a manufacturing county. The recent improvements in machinery for dressing cloth have all but superseded the use of teazles, and their cultivation will naturally be discontinued, which in an agricultural point of view is a desirable thing, as the teazle produces little or no manure to be returned to the soil. It has always been rather a precarious crop, and, not coming to perfection in less than two seasons, is necessarily an expensive one. It is usually grown on stiff clay soils.

Stock.—The stock of this district consists principally of cattle, which are kept for dairy purposes, and for breeding, rearing, and grazing. There are few extensive dairies, in consequence of the soil, as before stated, not being suitable for making the best quality of cheese. Cattle are therefore kept for breeding pur-

poses, and for the produce of butter for the neighbouring towns, where it generally brings a good price. The breeding stock are mostly short-horns or a mixed breed. Miss Strickland, of Apperley Court, introduced the pure short-horn into this neighbourhood some years since, with an advantage to her neighbours. There are a few breeders of Herefords; Mr. Barnes, of Tirley, has exhibited some very good ones at shows. The stock bred being mostly for dairy purposes, short-horns are preferred. The young stock, when weaned early and kept tolerably well, are brought into the dairy at two years old, but when kept on poorish land, not until three years. It is dangerous to keep young stock on too good land, as they are more subject to the murrain, whence the vale is not so suitable for rearing young cattle as the hills. Seeds are better for them than the pasturage of the old grass-land. In the extreme north-east of the county, at Marston, Honeybourne, Willersley, Wormington, and adjoining parishes, there are considerable dairies making fair cheese.

Loose pens for dairy-cows have been tried, where each has a separate place to itself, and are thought the best possible accommodation. The cows are kept cleaner with less litter than on any other plan, and much less hay is wasted than when in yards. A shed 9 feet deep, divided into pens 8 feet wide, with an outlet of 9 or 10 feet, besides a space for the crib and water, is about the proper size. Lord Ducie and Mr. Walters are breeders of excellent short-horns.

Sheep.—Scarcely any sheep are bred in this district. They are bought in from the Cotswolds, and at Gloucester market, for feeding. The land in moderately wet seasons is almost sure to rot them.

Butter, Cheese-making, &c.—It has been already stated that there are dairies in almost every part of the county, but the principal ones are found in the vales of Evesham, Gloucester, and Berkeley, and of the Isis and Thames, and on the borders extending all round it. Butter and cheese are made in the dairies adjoining North Wilts, which are sold in the neighbourhood. As before mentioned, much of the land in this district will not produce cheese of the best quality, although it may not be deficient in richness. It is too strong-tasted, and inclined to heave, or get hollow and full of eyes. The valley of the Severn, between Gloucester and Bristol, including the vale of Berkeley, is the most important dairy district of the county. The celebrated double and single Gloucester cheeses are made here, and most of the farmers make it their principal study to produce as much of those kinds as possible. Butter, veal, and rearing young stock are quite secondary considerations. They sell their calves when a

few days old, at almost any price they can get, after cheese-making has commenced.*

Cheese-making is not exactly alike in every minute particular all over the county, the methods not only varying in every district, but often in the same parish. Almost every mistress of a dairy has some secret, peculiarity, or mystery, fancied or real, which is often studiously kept from her equally clever neighbour. That there are greater difficulties in making cheese on some farms than others is clear. On two farms, with the *same soil and subsoil,* I found once the same quality of cheese could not be made *by the same person.* One farm is rather more marshy than the other, having several watery places, and some ditches growing flags and coarse grass.

From my own experience, which has been confirmed by inquiries made of others, I find that about 3 acres are reckoned for one cow, and the produce of cheese from 3 to 4 cwt. per cow, 3½ cwt. being considered a full average. It is only on very choice spots where 4 cwt. can be made from one cow.

Cider and Perry.—Gloucestershire is celebrated for the production of cider and perry, especially in the vale of the Severn, extending from Tewkesbury, through Gloucester, Newnham, to the mouth of the Avon. The deep red-sandstone soils are best suited for the growth of cider, and the colder clayey description for that of perry. The orchards, generally speaking, are tolerably well managed, but the crop is uncertain. The orchards which are situated on the eastern side of the vale extending from Cheltenham to below the New Passage are more certain of a crop than those situated in the vale, or on the western verge adjoining the Forest. The trees suffer severely from the easterly and north-easterly winds, which usually prevail in the spring, which sometimes frizzle up the leaves and blossoms as if scorched and burnt. I have often seen the orchards situated on the eastern verge of the vale, being sheltered from the biting north-eastern winds by the hills, escape altogether, when the orchards on the vale have all the blossoms cut off. The orchards of Gloucestershire give to it a densely wooded character, and form one of the most pleasing sights in the month of May that can well be conceived. Thirty or forty acres round a village will readily let, according to the age and supply of trees, at from 8*l.* to 12*l.* per acre. If trees are neglected they soon get overrun with moss. The usual remedy is to wash the stems once a year with a mixture of cow-dung and lime, which is laid on with a brush. The best manure for pasture-orchards is a compost of lime and soil spread on the

* There is a very good and faithful description of the mode of making cheese pursued by Mr. Hayward, in this district, written by Mr. Morton, and published by the Society for the Diffusion of Useful Knowledge. (See No. 21, Farmer's Series.)

surface in autumn. The practices usually adopted for making cider and perry have been described in your Journal (page 401, vol. iv. 1843).

Bristol District.

A glance at the map shows that the land here is very changeable, no large extent of the same description lying together.

The farms are mostly small, and many are not cultivated on any very regular system. On the heavy soils wheat alternates with beans and green crops, and on the light and sandy barley is grown, and turnips, vetches, and rye, for sheep-food. Near to Bristol a large quantity of the land is devoted to market-garden purposes, and many potatoes are grown about Stapleton, Mangotsfield, and St. George's. A considerable quantity of lime is used as manure in this district, which answers very well when laid on the fallows, before sowing wheat.

The following are the usual rotations of crops of the district:—

On Clay Soils.

Wheat and green crops alternately, or,

1. Turnips and potatoes.	4. Wheat.
2. Wheat.	5. Clover.
3. Beans.	6. Wheat.

Or the following:—

Wheat.
Beans.
Vetches.

On Loamy Soils.

Wheat.
Peas, and sometimes other green crops; white peas answering well.
Barley.
Clover.

On Light Soils.

Wheat.
Turnips.
Barley, Clover.
Clover.
Wheat, and sometimes green crops again.

The Forest and Ryeland District.

The Forest produces from its mines coals and iron-ore; much of it is waste and common, occupied by the miserable stock and donkeys of the colliers and other inhabitants. The Ryelands immediately adjoining the Forest are not generally farmed so well as the nature of the soil would allow, being of a sandy friable texture, well calculated to grow good crops of turnips, carrots, and other roots, without any extraordinary exertions. It is on the old red sand, the same formation as produces such heavy

crops on the eastern side of the Severn, though, as the name imports, they are of a lighter character, usually considered better fitted for producing rye than wheat. Wheat is now grown under fair management to a profitable extent, being from 14 to 25 bushels per acre under the 4 and 5 course system of husbandry. One thing peculiar is the use of lime as an alterative, or as manure necessary for the production of the usual crops. On the part usually termed "Over Severn," on the new red sand and red marl, the land is of a stronger texture, and much more difficult to manage than the appearance of the land would lead us to expect. This arises from its tendency to run and cake together after heavy rains, especially when it partakes of the saliferous marls, and is without the large particles of the new red sand. Much of this land requires draining, which would in a great measure counteract this tendency, and it is essential not to work it down too fine before winter. Although called red marl, it does not contain more than one-fifth of lime, showing that closeness or hollowness depends on the quantity of lime contained in the soil, and that on clayey soils a deficiency is more dangerous than an excess. On these heavy close soils the cropping and management are much the same as on the heavy lias clays adjoining, having naked fallows in nearly every course.

Usual Courses of Cropping.

1.	2.
Fallow.	Wheat.
Wheat.	Fallow.
Vetches.	Barley.
Wheat.	Beans.

Peculiarities of Management.

The first peculiarity I shall mention has long been practised on the elevated thin light soil of the Cotswolds, and the sensible farmer will not easily be induced to abandon it, although it may sound oddly in the ears of the Essex farmers, located on deep loamy and marly clays. The Cotswolds, as already shown, are composed almost entirely of calcareous rock, ranging from 100 to 200 feet in thickness, having at or very near the surface a covering of rubble unmixed with soil; and upon this a thin brownish soil of from 3 to 5 or 6 inches thick. The rubbly portion just under the soil is very porous, and the water passes quickly through it. The usual depth of ploughing is from 4 to 6 inches. The plough has, of course, been continually sliding over the surface of the rubble, but not penetrating it; and the wish of the farmer is not to do so, because he finds, if he does penetrate this rubble, the first rains that descend afterwards swill the soil into

the rock beneath, and he loses his manure. It is this that has made many a Cotswold farmer declare that he would rather have 4 inches of good soil enriched by manure than 8 or 10 inches deteriorated, as it would be by deep ploughing if it were attempted. It is, I am aware, not only desirable but imperative on the farmer to practice deep cultivation; but then he must have a soil to deep-plough, not a rock. There can be scarcely any question where there is plenty of soil, but here we can point out an exception. It is extremely doubtful where the soil is to be made, and especially if the farmer is to wait for his return until the rocks have become disintegrated and converted into soil. I advocate deep ploughing; but I wish to warn persons from hoping immediately to profit by it on thin light soils resting on a hungry porous rubble or compact level beds of slaty limestone. Neither can I advise the clay farmer to deepen his soil all at once, unless he means to stifle-burn. And it is not always that strong loams are immediately benefited by it. An instance occurred on a well-known farm in 1845, which may be cited as a case in point. One of the best fields of land on the farm, having 5 or 6 inches of good strong loam, on the top of patches of a thin yellowish clay interspersed with limestone rubble, was ploughed the usual depth in autumn; and in February, when being crossed, the ploughs were struck 2 or 3 inches into this yellowish clay, turning it up in slices upon the surface. This clay became baked hard by the sun. The land was well stirred and cleaned, and the lumps of clay mixed with the soil. The swedes were drilled with bones, &c., on ridges, with a good dose of rotten farm-yard dung deposited on the split ridges. The crop *all but failed;* whilst those of the neighbourhood were as good as usual. Another field was served in the same manner, but was drilled on the flat, which *was a complete failure.* Another field was also drilled on ridges, with bones, &c., having been turnips the previous year—*it also failed.* The party through whose management those failures happened was no doubt led by the *cry from without* to adopt deep ploughing without consideration, and expected he was about to turn up a mine of fertility.

To confirm my experience, not opinions, I need only point to the practice of one of the best farmers of our county. In some instances *he has not used the plough for years.* He states—

"I have five fields upon which I practise the breast-ploughing system exclusively, part of which *has been in cultivation eight years without being horse-ploughed,* and without having any other manure than the ashes from burning the surface, and the sheep's manure left in eating off the turnips. The land has produced five quarters of wheat to the acre, five times in eight years. I cultivate a great deal more land with the breast-plough, but not exclusively."

Mr. Beman, the gentleman alluded to, is a yearly competitor

for the Turnip and Swede Crop Prize, originated by himself and continued by Lord Carteret and others, through the Cirencester Agricultural Society, and is frequently a successful competitor. He obtained the first prize in the years 1838 and 1842, and a second prize in the years 1841, 1846, and 1847. His crops average 20 tons, and this without ploughing at all, or at most not more than 2 inches deep. Thin ploughing on moory soil or gravel has been long practised on the eastern borders of the county in the vale of the Thames.

Rist-baulk ploughing is usually performed on worn-out sainfoin leys. The operation may be understood by the phrase "cut and cover." It consists of first ploughing a *bout* from end to end, and then putting the plough into the turf at just double the distance from the furrow that can be turned clean, and holding it at that distance throughout. Thus a furrow is cut out which just covers an equal space that is not cut out or disturbed at all: the grassy surface of each is brought into contact, and during winter decomposition in some measure proceeds. The furrows cut out and turned up are not more than from 1 inch to 2 inches thick. The field when gone over in this manner presents a series of ridges and furrows, very like the ridging of fallows before winter. In the spring the scarifier is taken across the field presenting this series of ridges; and not only the furrow which was in autumn cut out by the plough, but the strip left untouched is removed. The field then presents a mass of sods, which are heaped up and burnt for ashes to be drilled with turnips. The rist-baulked ploughing is adopted to save the expense of breast-ploughing, or rather part of the expense, as it is a common practice to turn the furrow over, which had in autumn been ploughed up, to its place again, and on the top of it with the breast-plough to place the portion of the sward that had not previously been disturbed.

The burning after rist-baulk ploughing costs about 1*s.* per acre; breast-ploughing and burning, without rist-baulk ploughing, cost from 17*s.* to 25*s.* per acre. Little is gained over breast-ploughing.

Breast-ploughing and burning old sainfoin and other leys for turnips has been practised on the Cotswolds from time immemorial; and notwithstanding some very powerful opponents, has survived the threatened annihilation. It is peculiar to the Cotswolds; and strangers who argue from experience on their own soils only, or from theory, do not advise it. I am prepared to speak positively as to the good practical results derived from its adoption. I do not hesitate to say that greater improvement has been effected on those thin calcareous soils by breast-ploughing and burning than by anything else except the application of bones. Complaints have been urged against this practice, such as these:—Burning

once in seven or eight years must reduce the staple of the soil and render it lighter; by burning you drive off a large quantity of other substances that would by decomposition be converted into manure, and thereby deprive yourselves of enriching the soil by rotting the turf.

These arguments will appear satisfactory to such as have not seen its results. Against the first objection it may be stated that very little of the soil is burnt; but the roots of sainfoin, grass, and weeds are converted into ashes, and the surface-couch grass, which so much infests this district, is pared off and burnt with the sward, and is thus very easily got rid of, and not buried by the plough, and a summer's law given it to spread and flourish among a scanty crop of oats. I have some doubt also as to the large quantity of matter driven off by burning. That which is driven off is principally carbonic acid, and is not so great as has been represented. But admitting that we suffer a loss in this way, how much do we gain by raising an excellent crop of turnips or swedes by the ashes we obtain by burning and a few bones, without trespassing on the fold-yard! and how much do we gain by having acres of broad leaves stretched out, absorbing the carbonic acid from the atmosphere, which is appropriated by the bulb, and which, after passing through the stomachs of sheep, becomes deposited on the land! To breast-plough and burn, to obtain ashes to produce turnips, is not a much more unreasonable speculation than the sowing wheat with the expectation of reaping; and yet this practice is denominated a *barbarism.* By burning we perhaps may dissipate *hundreds,* but it is to reproduce *thousands.* The turnips, with their accumulated gatherings, should be consumed on the land, and white straw crops should never immediately follow breast-ploughing and burning. This is what is practised on the Cotswolds, and should be enforced where breast-ploughing and burning is practised. (See *Calculation,* next page.)

Having expressed my views on this subject, I shall be excused for mentioning a few facts. I know hundreds of farmers who have practised breast-ploughing and burning, but not one who discontinued it unless compelled. I know some landowners have objected to it as injurious, but not of a single positive injury sustained, or of any loss in letting a farm on which burning has been practised. On the contrary, many farmers have told me that burning has increased the produce, and I have a proof of rents having increased. I have burnt a clayey soil, somewhat sandy, where it did not do the good I expected, but I could see no injury it did to the soil. I have burnt land, the whole of it which is free from the sand, two or three inches deep, and have found great benefit arise in the succeeding crops. I know one farmer who removed all the soil down to the gravel, and after-

Breast-ploughing and burning Sainfoin Ley.

1 acre of Sainfoin Ley, broken up, and breast-ploughed and burnt :—

	£.	s.	d.	£.	s.	d.
Paring and burning	1	5	0			
Moving turf to dry .	0	3	0			
Rist-baulking . .	0	4	0			
Scarifying . . .	0	2	0			
Harrowing . . .	0	2	0			
Ploughing . . .	0	7	6			
Crosskill's roller .	0	2	0			
Drilling . . .	0	2	0			
Seeds	0	2	0			
Hoeing by hand .	0	12	0			
1 year's rent and taxes	1	15	0			
				4	16	6
Produce 15 tons turnips, at 7*s.* 6*d.* per ton . 5*l.* 12*s.* 6*d.*						
Oats after turnips :—						
Ploughing . . .	0	7	6			
Scarifying . . .	0	4	0			
Planting and harrowing . . .	0	4	6			
4 bushels seed, at 2*s.* 9*d.* . . .	0	11	0			
Hoeing and weeding	0	4	0			
1 year's rent and taxes	1	15	0			
				3	6	0
Produce 7 quarters at 22*s.* . . .	7	14	0	8	2	0
Produce brought down	5	12	6			
Value of 2 years' produce . . .	13	6	6			
Deduct expenses .	8	2	0			
Profit on 2 years .	5	4	6			

Ploughing up Sainfoin Ley, without breast-ploughing and burning.

1 acre of Sainfoin Ley, broken up, ploughed, and sown with oats :—

	£.	s.	d.	£.	s.	d.
Ploughing . . .	0	10	0			
Harrowing . . .	0	2	0			
Drilling . . .	0	2	6			
4 bushels of seed, at 2*s.* 9*d.* . . .	0	11	0			
Hoeing and weeding	0	4	0			
1 year's rent and taxes	1	15	0			
				3	4	6
Produce 5 quarters of oats, at 22*s.*, 5*l.* 10*s.*						
Turnips after oats :—						
Ploughing before winter . . .	0	10	0			
Ditto in spring . .	0	7	6			
3 times scarifying .	0	6	0			
Dragging and harrowing . . .	0	3	0			
Picking and hauling couch . .	0	5	0			
12 loads farm manure, at 3*s.* . .	1	16	0			
Hauling and spreading	0	5	0			
Ploughing . . .	0	7	6			
Drilling . . .	0	2	0			
Seed	0	2	0			
Hand and horse hoeing	0	12	0			
One year's rent and taxes	1	15	0			
				6	11	0
Produce 10 tons of turnips, at 7*s.* 6*d.* per ton . . .	3	15	0	9	15	6
Produce brought down . . .	5	10	0			
Value of 2 years' produce . . .	9	5	0			
Loss in 2 years . .	0	10	6			
	£9	15	6			

Thus making a difference of 5*l.* 15*s.* on an acre, which is much more than will counterbalance the difference between the next crops, one of seeds, the other of barley. After the seeds the breast-ploughed and burnt acre would have the advantage, being in wheat, whilst the other would be seeds or a green crop.

wards filled the space with the burnt soil: this spot produced increased crops and of a better quality for many years.

A few years since stifle-burning was introduced and practised in the lower parts of the county, round Marshfield, which is extending rather rapidly. It is done when the soil is in a dry state,

by setting fire to a small heap of weeds or an armful of straw, and covering it over with a little of the fine dry soil to prevent the fire from blazing, taking care not to put on too much until the fire gets strong. As soon as the fire shows any signs of breaking through, add to the heap more soil, which will require to be repeated every two or three hours. The fire should not be allowed to burn through and appear at the outside of the heap until finished. It is mostly practised on the stubbles after harvest in dry seasons, and sometimes on the fallows. Land which will burn in this manner must possess a large quantity of vegetable matter, and will not be injured by burning. On sandy soils it does not appear to answer; it is not very easy to get such soils to burn.

Clearing wheat-stubbles and burning the rubbish has been practised in this county for many years, the object being to obtain stubble turnips, the same year after wheat; and in case of not obtaining bulb, to secure at least some green food for the sheep in the spring; as soon as the wheat is harvested, and often before it is carried, to skim-plough and harrow the land, then to rake together the stubble and rubbish, and burn it, spread the ashes, and sow the turnips. A very plentiful crop of weeds generally soon exhibits itself, which is hoed out, if the turnips promise to become a crop; and lately it has been a custom to clear the land of stubble and rubbish, and after burning it, plough the land and drill the ashes with vetches. This method of clearing stubbles is a most excellent practice. It very much facilitates the after clearing of the land, and is a saving of time, when time is of more consequence than it usually is, between harvest and wheat seed-time.

In the vale of the Thames and on the Cotswolds there is a practice of autumn-manuring for turnips, either ploughing it in or covering it with the breast-plough. It is adopted by some of our best farmers. The dung is hauled on the land in November and December, and ploughed in and left all winter. In the spring the land is ploughed and cultivated, and the swedes or turnips are drilled with bones and ashes, &c. The manuring and ploughing in is going on in one field, whilst in another we see the manure being breast-ploughed in. In one of my excursions over the county I found a man in a field at this work. He was paid 8*s.* per acre for spreading the dung and turning it in, and he made very good work. And on the adjoining farm I found a man breast-ploughing wheat-stubble, which was not manured. The price was 7*s.* per acre. It was not intended to burn afterwards. He was turning it over little more than an inch deep. What would indiscriminate deep-ploughers say to this? And this was on the farm of a nobleman who is a great patron of agriculture,

and whose agent is a most excellent farmer. The farmer who has half his land intended for turnips thus autumn-manured experiences no difficulties in the spring. His work is half done. The other portion of his *fallow* is in vetches or to be sown with spring vetches, which are consumed on the land, and succeeded by turnips.

It has long been the custom with the Cotswold farmer to plough up his second year's seeds in July, in preparation for the wheat crop which is to succeed. The feed is worth but little after midsummer, and it has been found from experience that it is best to sow wheat after seeds on what is termed a *stale furrow*. The land is ploughed in July, and left for a month or six weeks exposed to the effects of the atmosphere. It is then rolled, and at seed-time it is well harrowed and drilled, and the land has the appearance of having had a clean fallow. Not a sod is seen on the surface. The practice on those calcareous soils, which are subject to the grub and wireworm, is no doubt a good one. Occasionally it happens that a farmer ploughs in autumn and sows immediately afterwards. The land is seen scattered all over with sods, each of which becomes a home for the grub, wireworm, and slug, which feed on the young and tender wheat-plant. By ploughing early, and obtaining a decomposition of the grass and sods, &c., the vermin are deprived of food and shelter, and either perish or depart elsewhere.

There is a peculiar practice which has been long established, and which was quite essential on our light lands, before the late rapid improvement in agricultural machinery. The ring-roller and Crosskill's clod-crusher are taking the place of the hoof. The practice is, immediately after the harrows, in wheat seed-time, to herd all the young and lean beasts on the farm, and drive them to and fro over the land after the harrows, ridge by ridge, as they are finished by the harrows, and in this manner the whole field is gone over, to consolidate the soil. The same has been done with wheat and barley in the spring.

The folding of sheep at night on the fallows in preparation for wheat is done with a twofold object—to supply manure and to consolidate the soil. Its utility has been questioned, at least it is observed, mostly by parties who have not had much experience, that sheep suffer to as great extent as the benefit to be derived from the folding. On heavy soils this may be the case, but heavy soils would not be benefited by consolidation. On chalk downs and oolitic downs, on the Cotswolds, sheep suffer very little inconvenience from the practice, and the benefit to the land is considerable, especially on lands which do not produce many vetches. On lands that produce good crops of vetches, &c., it is not indispensably necessary to fold, a manuring is obtained without

it. Sheep manure is very genial for wheat; and in down counties, with a Southdown flock, we most assuredly should recommend its continuance. A coat of sheep's dung, half an inch thick all over a hundred acres of down pasture, would not be a tenth part so profitable as on the same extent of wheat land. In parts where downs are found not worth breaking up, this practice will be continued, and we say properly so.

The management of the turnip land and the turnip crop becomes a peculiarity on account of the necessity of having the land *firm*, although mellow and healthy underneath. Drilling turnips on the back of land ploughed up from seeds is practised. I have mentioned this to farmers who would scarcely believe it. I know where turnips are now growing on land which had had vetches fed off in rather *wet* weather. It ploughed up raw, and *to appearance* unkind for turnips. On another portion of the field the vetches were fed off in *dry* weather, and the land ploughed up mellow afterwards. The whole field was left for some time after it had been ploughed and became thoroughly sunned. When rain came it was harrowed and drilled. There are turnips where the land had been trodden by the sheep in the wet; but *none on the other.* The reason I will not attempt to explain; it is a fact, and has its foundation in the peculiarity of our soil. We could mention many facts in support of this kind of management, although contrary to the far-famed Norfolk and northern practices, where the grand essential to secure a good crop is a deeply pulverized soil, but which, as has been before mentioned, failed to produce a crop here, in one of the best turnip seasons which we have experienced for several years. In 1846 the poorest, thinnest piece on the same farm was sown with turnips, and cultivated thus:—The land was seeds in 1845; in the spring of 1846 it was breast-ploughed and burnt, and the ashes left in heaps for some time before being spread. The land was ploughed rather thin (it could not have been ploughed deep without turning up the rock), and the turnips were drilled *on the back of the unbroken furrow*, and rolled in. They came up very thick, were singled out, but *not deeply hoed until the leaves covered the ground.* When hoed, the furrows were chopped to pieces, and the rubbish brought to the surface. The turnips grew beautifully, and were *the best crop the farm ever produced.*

The consumption of hay in the fields during winter when eating off the turnips has long been the practice of the Gloucestershire farmer. Sainfoin hay, clover, and seed-hay, or hay from meadow is used, as circumstances require. It is carried to the turnip field in the hay-making season, and ricked in the most convenient place; and when the turnips are eaten off, the rick is cut and carried to the fold, and placed in racks for the sheep. About

a ton per acre for the turnip field is usually consumed on the land. Independently of the good effect it has upon the sheep, it is also very beneficial to the land. The consumption of a ton of hay, whether the turnips be a good or inferior crop, retains the sheep much longer on the soil, and the consequence is, both a better manuring and a better consolidation of the land. The great majority of farmers not only consume hay thus on the turnip land, but give to the fat sheep corn, oilcake, and hay, cut into chaff. The attention paid to the rearing and fatting of sheep in the vale of Thames and on the Cotswolds can scarcely be exceeded by any other county, as the prices obtained by our numerous sheep-breeders at the annual ram sales will testify. The shepherds in this county are provided with a portable house, or cot on wheels, to which they resort for rest and shelter in the yeaning season.

Ploughing with from three to four horses in a team at length, and a boy driving, has until lately been the custom of almost every one, not only in the county, but those which surround it. On light lands this practice seems ridiculous in the eyes of strangers, who may think because the land is light and thin it is easy to plough; but although thin, not of deep soil, it is, on account of the large quantity of carbonate of lime it contains, very sticky, and the plough never cleans itself, and every ploughman knows that when this is the case it is difficult to make good work and not so easy for the team as is imagined. This is now disappearing, and ere long a pair of horses will be deemed sufficient on all but the heaviest stiff lands of the vale. Draining will much tend, as it has already done, to render so powerful a plough-team unnecessary, and when no longer needed it will not be continued by the present race of farmers.

Oxen have been much in use at plough in many parts of the county, as well as in waggon-teams. The bull too is worked by many farmers as a *cart-horse*, and a most enormous quantity of drudgery he willingly performs. I have frequently admired the docility of the animal, and his wonderful power in the cart-shafts, a place which he frequently occupies, regularly harnessed like a horse. I have often seen him led to the field by a boy, and sometimes by a woman, as quiet as a lamb, and bring back an enormous load of turnips. The employment of women for nearly all kinds of labour but thrashing with the flail, may be accounted a peculiarity of the county if not the country. We find the women not only weeding corn and assisting in hay-time and harvest, but engaged in wheat and bean planting, hoeing wheat, beans, and turnips, &c., assisting to distribute the dung when planting swedes and turnips, &c., and in getting up and storing them; and also in the sheep-fold in the winter pulling and cutting turnips, working the chaff-cutting machine, assisting

to thrash with the machine and steam. Hedging and ditching, ploughing and mowing, are almost the only things which we have not seen performed by the Gloucestershire women.

For ages the Gloucestershire farmer has been aware of the benefit of planting in drills, and most probably practised it when no such practice was adopted elsewhere.

Before drilling-machines were invented the Vale farmer planted his beans in rows across the ridges by hand, and sometimes his wheat; the saving in seed paying for the labour. This was done by women, but the use of machines is now superseding *hand*-bean planting, and has altogether superseded wheat setting, and promises soon to scare away broad-cast sowing from off the land.

When the Gloucestershire farmer kills his pigs, he does not scald them and scrape off the hair, as in the north, but burns it off with straw, which is called *swaling*, a less troublesome practice than scalding.

The slow movements of the labourers in this county is not a peculiarity which attaches to it alone; like many others named by me, it applies to the whole west. This fact cannot have escaped the observation of strangers, and of itself must be a *serious obstacle* to the rapid progress required in many of the farmer's operations. This slowness necessarily extends itself to the working cattle, and many times have I been compelled to look at some tree at a distance to ascertain whether or not the plough-teams were moving, but we seldom see the team altogether at a stand except in the middle of the day for a few minutes, when the oxen sometimes take the liberty of lying down, while they chew the cud with all the ease and unconcernedness conceivable. The removal of this obstacle to the farmer will not be easily effected. The boy at an early age gets inured to it, and it will be found a difficult task to alter his habits which have been early formed.

The Cotswolds have for many years been celebrated for the breed of sheep, but the Cotswold sheep which have taken the name from having originated there are not the Cotswold sheep of the present day.

Our two divisions, Vale of the Isis or Thames and the Cotswolds, possess many excellent flock-masters, who have become justly celebrated for their stock. To do justice to the sheep in this district would occupy a volume of itself, and will claim a short notice in another place, our business here being to do little more than record that the improved Cotswold sheep are a distinguished peculiarity of the county of Gloucester, and the eastern portion of the county is celebrated for the number of farmers who have assiduously devoted their energies to the selection, breeding, and improvement of rams, which are annually let and

sold by auction. The following is a list of the average prices realized at some sales in 1847 :—

	£.	s.	d.	
1st sale the average was . . .	9	1	0	per sheep.
2nd ,, ,, . . .	10	6	8	,,
3rd ,, ,, . . .	9	4	0	,,
4th ,, ,, . . .	9	3	4	,,
5th ,, ,, . . .	9	10	0	,,
6th ,, ,, . . .	7	4	0	,,
7th ,, ,, . . .	7	15	0	,,

Single sheep have realized more than double the above averages.

Improvements effected since Mr. Rudge's Report.

The establishment of the Example farm at Whitfield was undertaken at the suggestion of the present Lord Ducie.

After spending a large sum in draining, making roads, and removing all the hedges but the boundary fence, the farm was let to Mr. John Morton, who holds it as tenant under his lordship at the present time.

The following is Mr. Morton's statement of the intended mode of cropping:—

"The course of cropping which I propose to adopt for the clay soil is the following:—

No. 1.—7½ acres of swedes, manured with dung and bones. This crop to be consumed on the land by sheep. 7½ of mangold-wurzel, with dung and bones. This crop to be carted off the land and consumed in the yards.

No. 2.—7½ acres of wheat after mangold-wurzel. 7½ of beans after swedes. Clover and seeds to be sown amongst the wheat and beans.

No. 3.—15 acres of clover and seeds, one-half to be carried off the land and consumed in the yards; the other half to be consumed on the land by sheep.

No. 4.—7½ acres of wheat on that portion which provided the beans the previous year. 7½ of oats, after that which was wheat the year before.

No. 5.—7½ acres of turnips, early tankard, after oats. 7½ of winter vetches after wheat, both crops to be manured and consumed on the ground hy sheep.

No. 6.—15 acres of wheat.

The course of cropping I propose for the sandy loam is as follows:—

No. 1.—7½ acres of swedes, dunged. This crop to be consumed on the land by sheep. 7½ acres of mangold-wurzel, dunged. This crop to be carted and consumed by stock in the yard.

No. 2.—15 acres of barley sown with grass and clover seeds.

No. 3.—15 acres of seeds to be consumed on the ground by sheep.

No. 4.—15 acres of oats.

No. 5.—7½ acres of cabbages, on that part where the mangold-wurzel previously was, to be manured. This crop to be consumed on the ground by sheep. 7½ of potatoes, to be dunged and consumed in the yard.

No. 6.—15 acres of wheat.

The course of crops I intend for the limestone is as follows:—

No. 1.—5 acres of vetches and rye, to be followed by late cole-seed, to be dunged. This crop to be consumed on the land by sheep.

No. 2.—5 acres of barley with clover and grass seed.

No. 3.—5 acres of clover to be consumed on the land by sheep.

No. 4.—5 acres of oats.

No. 5.—5 acres of globe and tankard turnips, dunged. This crop to be consumed on the land.

No. 6.—5 acres of wheat."

In 1846 Mr. Morton states that twelve men, seven women, three boys, and extra hands in harvest, were employed on this farm of 240 acres, which was previously a poor dairy-farm giving no employment at all, and that the wages of the men were from twelve to fourteen shillings per week and that his crop of wheat on 120 acres, being half the farm, was 575 quarters. Wheat is the only grain grown on the farm. He purchases annually 20 tons of oil-cake, 20 quarters of oats, 5 quarters of peas, and 15 quarters of barley and maize. When the improvement of this farm was first undertaken by Lord Ducie, Mr. Morton published his intended course of cropping, which embraces barley and oats; but on taking to it himself he changed his system, for on visiting the farm in November last we found that half the farm was regularly sown with wheat and the other half with green crops, which comprise seeds, clover, beans, carrots, turnips, swedes, mangold-wurzel, and kohl rabi, &c.

His turnips and swedes had failed, but his mangold was an excellent crop, which he was harvesting at the time of our visit on the 4th of November. He stores mangold, carrots, and swedes in long ridges between hurdles, which are thatched with straw. The cattle are fed in boxes 9 feet square, but the dung is removed occasionally. Pigs are kept in a building and hurdled off in compartments, and the litter allowed to remain under them as under the beasts in the boxes; and sheep are fed under sheds, not boarded. The cattle-boxes have a passage all the length of them, from which food is placed in the cribs, which are movable and ascend with the ascent of the accumulating dung, and a trough with water is placed in each. The stable consists of stalls partitioned off, with a floor over and a store-room at the end, which contained, when we saw it, a quantity of washed white Belgian carrots, ready to be given to the horses in a raw state. The carrots were washed by a machine. The rick-yard is situate on the north of the barn, and on ground a little more elevated. It is an oblong square, with a row of ricks on each side, placed on round staddles, and a road elevated about 2 feet above the general level forms a passage down which to bring the loads of corn. The ricks are not large; Mr. Morton states they contain about 300 sheaves, and will produce upwards of 40 sacks to a

rick, varying of course with the yield. The carrying the corn from the field to the rick and ricking are done by piece-work, which costs 10*d.* per acre. The thrashing is done by steam; the engine is a snug piece of machinery; it takes an hour and a half to get up the steam, and in the morning, whilst this is being done by one party, others are stripping the rick and preparing for carrying into the barn. This is done by laying down a wooden railway on the elevated road, which is in the middle of the rick-yard, between the two rows of ricks, to the machine inside the barn; and a carriage with wheels and axles to fit the rails is taken from the barn to the rick and loaded. When the engine is ready the business commences, and the loaded carriage is moved down the railway into the barn and unloaded, by parties who place the sheaves on the teeth of a revolving rake, by which they are elevated and placed on the floor above. The sheaves are taken by women and handed to the feeder who serves the machine, and this is uninterruptedly continued till either the rick is out or the usual meal-time causes a temporary cessation. The machine not only thrashes the corn, but shakes the straw, winnows the corn and causes it to pass down a spout to the ground floor, to which spout a bag is attached, which, when full, is removed by an attendant, the corn being winnowed, screened, cleaned, bagged, and ready for the market. A register of the performances of the machine is kept. The thrashing, including the wear and tear of the machine and engine, which have hitherto been trifling, and not likely to be ever very great until worn out, on the average come to 10½*d.* per quarter. This includes every expense, coal, labour, and repairs. Cultivators, harrows, rollers, &c., are all of the modern and best construction, and one-horse carts. He drills all his crops and sows winter beans, between the rows of some of which we saw drilled carrots. A slight waste, however, was suffered last year from the loss of the *britted* beans. The pigs could not be allowed to pick them up for fear of disturbing the very fair crop of carrots, not less than *twenty-five* tons to the acre, which were growing, when we saw them, very rapidly. Thirty bushels of beans per acre had been reaped. The turnips and swedes were a failure, as before noticed, from the ravages of the grub, but the mangold-wurzel was very fine, not less than 30 tons to the acre. The swedes generally average about 20 tons per acre.

The buildings are plain and useful, and are arranged in a square, having the barn steam-engine, boiling and steaming apparatus, piggeries, and stable, on the east: implement-shed to the south, on one side of the roof; and the cattle-shed, now converted into boxes, on the north, sheds for sheep, &c. A division runs east and west across the centre of the yard, which

forms a shed; having on each side of the centre of the roof pens for sheep, which are open to the yard, and are separated by the wall which rises from the ground to the apex of the roof. The repeated growth of wheat on this farm every other year, without, as far as we know, any diminution, is easily accounted for by the consumption of seeds in folds on the land, and the large quantity of manure made from the consumption of so large a weight of turnips, swedes, mangold-wurzel, carrots, &c., as is usually obtained on this farm. Thirty-eight bushels of wheat per acre, on 120 acres, appears to be a great crop; but it is not, in comparison, so very much higher than what is usually obtained on similar soils by the Gloucestershire farmer. The crops will average 32 bushels per acre, to which if we add what Mr. Morton grows on the land that used to be in fences, which is equivalent to 3 bushels per acre on his entire wheat crop, we bring the comparison into this position, viz., he gains 3 bushels per acre on his entire crop by extra cultivation and management, besides getting wheat every other year; which they do not always —although they very often have wheat once in three years, and sometimes, like himself, every other year.*

Since the time of Rudge, and, indeed, within the last seven years, a very great improvement has taken place in all parts of the county. In the vale of the Thames there are many farmers who have adopted the use of one horse-carts instead of waggons, have drained their farms, being met half-way by their landlords; have cut down their high and wide hedges, and adopted the method of cropping them yearly; have abandoned summer fallows, who sow winter and spring vetches, which are eaten off by sheep in folds, and the land afterwards cultivated and sown with turnips; have adopted the plan of autumn cleaning stubbles, manuring in autumn the land intended for swedes in the spring; who drill all kinds of grain; who plough with two or sometimes three horses, instead of with four or five, and plant mangold and carrots, parsnips, kohl rabi, and who soil stock in yards and box-feed their cattle.

Bones were not in use in the time of Rudge, but are now become general. The improvement effected by their use has nowhere been more beneficial than on the calcareous soils of the Cotswolds, and the gravel of the vale of the Isis and Thames.

Turnips have always been considered the foundation of all good husbandry on light soils, and their growth could not be more beneficial than on the Cotswolds; but from the elevated and exposed situation, and the want of some stimulant to start

* It must not be forgotten, however, that this was previously a poor dairy-farm, paying neither landlord, farmer, nor labourer.—Ph. Pusey.

them in their early stages, and vigorously to push them on out of the reach of the fly, the crop was deficient and uncertain.

The use of bones has for many years been common on the Yorkshire wolds and in other parts of England, and was found to answer very well. At length they were introduced into Gloucestershire. In 1834, Mr. P. Mathews, a spirited farmer, erected a bone-mill on his farm at Coombe-end, and very soon his excellent turnip-crops attracted attention, Their use soon spread, and has now become general. This farm is situated in an elevated exposed part of the Cotswolds, and not twenty years ago was proverbial for the lateness of the harvest. Now, from his excellent turnip and sheep management, and general improvement, his harvests are as forward as those on more favoured soils, and equal—if not superior—in produce to those of his neighbours who are more advantageously situated. A marked improvement has been observed in the crops since the introduction of bones, particularly on his own farm, but also in the great majority of others in the district.

On Lord Bathurst's farm, Mr. Anderson has had beans and mangold as a double crop. The beans were drilled in double rows, with an interval of 3 feet. In the spring the mangold was planted between the double rows in the centre of the wide space left. At harvest the wurzel was very regular, but not so large in bulb as those planted without beans; but, on the beans being removed, the wurzel grew very rapidly, and, when removed for storing, the roots were little inferior in weight to those where no beans had been planted. The land, of course, was not so clean.

Mr. Slatter of Stratton, and others, drill about 1 cwt. of guano and ashes from turf, with vetches, which answers well; the vetches treated so this autumn are the finest I ever saw. For the last six or seven years several of the best farmers have adopted the method of cropping their hedges, and keeping them so cropped; and have thus brought into cultivation a considerable portion of land that was truly waste, and have removed a great number of unnecessary hedges, put drains in the ditches and covered them over, and grubbed vast quantities of old pollard-trees from the hedgerows that are left. Nothing could be more improved in this respect than many farms in the county: Mr. Cook's farm at Down Ampney, Mr. Edward Bowly's farm at Siddington, Mr. Bubb's farm at Whitcombe Court, Mr. Slatter's farm at Stratton, Mr. Clifford's farm at Frampton, and the College farm at Cirencester.

The recent establishment of the Royal Agricultural College cannot be passed over in silence, but it would occupy too much space to sketch its history and its objects; I must be satisfied, therefore, to state that it has been established for the education

of gentlemen's sons who desire to follow agriculture either for a pursuit or as an amusement; and for the sons of farmers, who are intended to follow farming as a business by which to obtain a livelihood. The College building is situated on a farm of 410 acres, including woods and plantations, and occupies the site of the farm-yard formerly called "Starveall Farm," which was afterwards known by the name of "Port Farm," and now the "College Farm."

Since the time of Rudge an enormous quantity of draining has been effected. It has become so general, that there is not a parish, scarcely a farm in the county, but has had some draining done on it since 1813, a great deal since 1830. Stones, tiles with soles and pipes, are now the principal materials; and within these last five or six years pipes have come greatly into use. Many tile-yards have been established in the county, at which pipes are manufactured.

Since October last I have purchased not less than 180.000, with which I have drained 108 acres, and have under hand 80 more: some parts at 4 feet deep. The cost, including pipes, &c. is a little under 4*l.* per acre. Some of the land is greatly improved by it; and one tenant, before our commencing it, agreed to pay an advanced rent of 10*s.* per acre, on the condition that we drained the land. Since 1813 many tile and pipe factories have been erected for the manufacture of tiles and pipes for draining; and within the last seven years the cost has been very much reduced, in consequence of the general introduction of machines for making pipes. Pipes are made of several sizes, and sell at various prices: a list of such as we have used is as follows:—

	£.	*s.*	*d.*	
1 inch diameter	0	13	0	per thousand.
$1\frac{1}{4}$ „	0	16	0	„
$1\frac{5}{8}$ „	1	0	0	„
$2\frac{1}{4}$ „	1	4	0	„
3 „	1	10	0	„

A discount from these prices is allowed for ready money. Probably they may be had in some parts of the country somewhat under these prices.

18 inches used to be the minimum, and 30 inches the maximum depth. From 30 inches to 3 feet is now the usual depth, but occasionally 4 feet. About one-fourth of the land in the vale has been drained, part of which is not effectually done.

There is an open drainage of part of the parish of Kempsford mentioned by Rudge which is still worthy of notice, as we may there see what can be done by having a command of distance in a flat district. This parish lies mostly between the rivers Thames and Coln. For a distance of between 4 and 5 miles, at the time

of the enclosure, two new drains were cut, commencing at the lowest point of the parish. These were to drain an extensive tract of flat moory land, some of it under the level of the river adjoining. It answers the purpose; keeping it much drier than before the enclosure, when it used to run into the river in several places at a much higher level. It was awarded to be kept clean by the several occupiers, for which and other purposes a court is held annually to enforce it. By this drain and the ditches round the fields being kept clean, this flat land is perfectly drained. Being on a subsoil of clean gravel, it drains the whole land without any underdrains, in the same manner as mentioned in the Journal, vol. vii. p. 522, by Mr. Pusey. Nothing of this kind could have been done, had there not been a command of *distance*, without the aid of Parliament. I think some power should be granted to magistrates or other authorities to compel parties to cleanse their present watercourses, and authorize the cutting of others where required. I know lands which are now suffering for want of the exercise of such power.

In the vale above Gloucester this cause makes it impossible to do much good by draining in some parishes, until a more general system of opening and levelling the watercourses be obtained. The proper drainage of this district is a much more urgent case than the one mentioned on the moory soils adjoining the Thames. The want of proper drainage must materially affect the climate and forwardness of the season, especially after a wet winter or spring months. In fine seasons hay-time and harvest are as forward as on the gravels of Kempsford and Down Ampney; but after a wet winter or wet spring it is not so, yet the gravel district is 200 feet above the vale. This would practically indicate that a warm soil properly drained makes a difference in situation of at least 200 feet on the scale of elevation.

A great improvement has been made in the erection of farm-buildings for the convenience of stock by many landowners who have or have had farms in hand. Improvements of this kind have been made at Forthampton, Dumbleton, Southam, Boddington, Haresfield, Frampton-on-Severn, Tortworth-court, and Whitfield-farm. Many spirited and truly patriotic gentlemen have liberally come forward and set the example, which has been followed by many active intelligent farmers. On the hills and vale of Thames the improvements in building have still made greater progress, because of being more general. It has extended to almost all farms of any size. At Tortworth, Weston, Birt, Cirencester, Fairford, Down Ampney, Southam, Withington, Coombend, Sherborne, Donnington, and elsewhere, both owners and occupiers have made great improvements within the last twenty years. Some of them have almost entirely rebuilt

their farm-houses and outbuildings, and which, generally speaking, are very well arranged, the cattle-stalls having a passage along the building at the head of the stock for the purpose of supplying them with food, and troughs of water placed in every stall, with stone guttering to connect each trough, by which means a constant supply of fresh water is maintained. Some of those stalls are now converted into boxes, and have the beasts loose in them, treading their litter into manure and mingling it with their dung and urine, which remains thus consolidated under them for months, in some instances until the stock is removed to the slaughter-house. It would be doing great injustice to many of our excellent tenant-farmers not to acknowledge that they as well as the landowners have done as much towards improving the buildings and draining the soil as the position in which they are placed will warrant; whilst others with whom we have to come in contact are excessively careless, and, as it would appear to us, would not drive a nail if a hammer were placed in their hands, nor lift a stone on to a tumbling-down wall, or place a handful of thatch on to the naked rafters of a shed, even if it were of more benefit to themselves to do so than to their landowners.

Water is generally plentiful in the vale, and is retained by pools, either natural or made by removal of clay; and in places on the sides of the hills the lands and farmyards are plentifully supplied with springs; but on the Cotswolds there are many farms whose only supply for the house and yards is from a very deep and uncertain well, and for the fields by artificial pools made at the union of two, three, or four fields. These pools are clayed and pitched, as in the time of Rudge; but about eight or ten years ago a self-acting engine was constructed and brought into use on several farms with which we are well acquainted, and is found to be of great use. The engine consists of an overshot, undershot, or breast-wheel, as circumstances may require, but slightly made. When complete and in motion this wheel works a beam vertically, to which are attached by rods one or two pistons; and valves are placed in pipes similar to those in force-pumps, through which pipes the water is driven to the place of delivery, which is a large cistern placed usually on the top of the house. When the cistern is nearly full a means of escape is provided, and the water passes into troughs, ponds, or the yards, for the use of stock. This machine is continually at work, and never ceases until something is out of order, or the water by which it is driven becomes short. At Knole Park, near Bristol, there is one with an overshot wheel 12 feet in diameter and 18 inches wide. It is placed just below the head of the fish-pond, and the water that drives the wheel is supplied from the pond above, and is con-

ducted on to the top of the wheel by means of a pipe 2 or 3 inches in diameter. This spot is at least 300 feet below the house. This wheel works two force-pumps; and, what will probably appear singular, they drive the water of a spring, which is half way up the hill, through pipes to the top of the house. The rate is a gallon per minute. Several others have been erected in the county: at the White Way Farm, at Cirencester, the property of Miss Master; at Sapperton, the property of Earl Bathurst; at Colesbourne, on the property of Henry Elwes, Esq.; at Ampney Crucis, the property of the late G. G. Blackwell, Esq.; and at Katherop Castle, the property of Lord de Manley.

Stock and its Management.

On the hills the improvement in the management of the flocks is plainly proved by the weight and age at which they are brought to market, compared with what they were at the time of Rudge. He says that when *three years old* they would weigh from twenty-two to thirty pounds per quarter; now they are brought to that weight at *fifteen months* old only. I once saw a sheep hung up at Stow May fair which weighed forty pounds per quarter at this age. There is, also, a greater number kept. On one farm the flock of Cotswold sheep used to be managed in the same way as is now followed on the hills; that is, running at large in separate fields, feeding on the young and old seeds. The number of ewes kept for many years varied from 100 to 110. The present occupier, seven years since, noticed the folding-off system practised in Wiltshire through the summer, on vetches, clover, &c., and tried it a little at first, increasing as he felt the benefits. *His stock is now* 150 *ewes of the same breed, and the increase is owing wholly to the folding off system.* The whole of the Cotswolds cannot be thus managed, as the soil in some instances is so thin that it would scarcely grow any seeds or green food, except rye-grass—the worst thing possible to fold off: but it can be done on the best land of most farms.

The climate and appearance of the Cotswold Hills have been much improved by belts and patches of plantation scattered over them. It is also a profitable investment where the steepest, wettest, and poorest land is planted, which is often the case. The only drawback is where game has been preserved to excess. Wood-pigeons, too, have become very numerous and destructive to the crops, not only of corn, but vetches, clover, and swedes in winter. In some places vetches can no longer be sown for feed. There is a full average quantity of game preserved in the county, sufficient in some places to injure materially the crops of the farmer.

Railways have afforded great facilities for the transmission of corn, butter, cheese, milk, and fat stock to London for sale, and

have been the means of introducing to the world guano, oil-cake, linseed, &c., more easily than was experienced before, and have otherwise, to some considerable extent, been of use to the agriculturist.

Improvements still required.

In the Vale of the Thames, on the Oxford and forest-marble clays, and on the cornbrash, which is generally so thin as to be much injured by the retention of water on the forest-marble underneath, much draining has been done, particularly within the last seven years. But I know this district well, having, for some purpose or other, been into almost every field; and I find only about a fourth part of the draining executed that is required. The execution of the remainder is an improvement still required; and draining on many of the soils will make an excellent return to the landowner.

On the Cotswolds little draining is required. In places where the fuller's earth comes to the surface, and crosses arable fields in narrow belts, it is required, and ought to be executed; but generally these spots should be trenched and planted with ash coppice. The soil is worthless as arable. Also draining is required at the bottoms and sides of the valleys which so fantastically furrow up the Cotswolds. Some is already done; but not half of that which is required.

If a portion of the highest and driest part of the county requires to be drained, what shall we say of the Vale? At one time all the vale required it; and now, in proportion to the extent, it requires more than any other division of the county. It would, indeed, effect little good on some portions near the Severn; but not a fourth of the land of the vale has been drained, and *not less than half* the Bristol and Forest district still requires it.

Draining having been properly and judiciously executed, a higher culture of the land will be sure to follow, because the farmer will obtain a better and more certain return from the soil, and can work and cultivate it more easily, and consequently perform it more effectually, and thus general improvement will result. But it is not only on land that requires to be drained where still further improvements are requisite. In taking a hasty glance at our best farmers; we feel, and they know it themselves, that improvements can and must be adopted as soon as circumstances will permit it. We are pleased to find them not only encouraging but originating improvements, and have to regret that their spirit and example are lost upon or disregarded by many of their neighbours. Nothing is more striking to strangers when crossing the Cotswold district than the foul state of some of the wheat stubbles. This stain upon the character of the

farmer should be removed. The greatest room for improvement is amongst the smaller description of farmers. I know many that are an exception, and are as forward in improvements as their more wealthy neighbours; but the number of such is small compared with the total number of farmers of the county. Many of the farmers drill nearly all their crops, but further advances may be made in this art, which will enable them more thoroughly to eradicate weeds than is now the custom. It is not every farmer who weeds his spring corn—barley and oats—which we conceive ought to be done, as well as the weeding and hoeing of wheat and beans. I have seen many a crop of wheat reaped without ever having had a hoe put amongst it, of course not free from thistles, docks, &c., which after harvest have become beautifully exposed, teeming with seeds sufficient to stock a whole parish. In 1845, on a farm on which in future probably scarcely a dock will with impunity show itself again, I carefully secured a flourishing plant, and found it to contain no less than 4000 seeds. I mention this to show what grievous folly it is to allow things of this kind to flourish and take possession of the soil.

To make the most of the land it should always be cropped with something or other; and although this practice cannot literally be accomplished on large farms, still a nearer approach to it is requisite. All the stubble, except the portion intended for early swedes, should produce a vetch or green crop, and be followed the same year with swedes and turnips; and that on which swedes are intended to be sown may often be cleaned immediately after harvest, and sown with stubble (stone) turnips or with tail cow-grass, to produce a green crop for lambs in the spring, which, when consumed, should be ploughed and cultivated for swedes. On heavy soils vetches may be sown and eaten off with sheep, and afterwards fallowed for wheat, which practice would be greatly superior to an entire summer fallow. The growing of vetches on light lands, and having them consumed on the soil, and followed the same season by turnips, is an excellent practice; and some of the best farmers here, for the purpose of securing a crop, have drilled them with ashes and guano, about 1 cwt. to the acre. The most promising vetches I ever saw were drilled in this manner on some hungry dead soil. They will be folded off with sheep in the spring, and followed with turnips to be drilled with bones and ashes.

Shed and yard room for the shelter of stock, and in which to consume the fodder and straw of the farm, and to insure its conversion into manure, is still much required. I not unfrequently see cattle kept in fields all winter, and a *little straw or hay, or both, given them by being strewed on the sward.* Every farmer has long known the mischief done to sward-land by the treading

and poaching of stock in winter, and he is now beginning to see that shelter and warmth are equivalents for food, and that the abandonment of field-foddering will improve stock as well as his land. As well as more provision for young stock, more sheds, stalls, or boxes are required for stock generally. With a greater abundance of the root-crop and green food a necessity will arise for better provision for the economical consumption of part of it in sheds and yards. In new erections of farm-buildings this should be borne in mind, and less money expended in the erection of *enormous barns.* Three or four are sometimes met with on a farm of 500 or 600 acres. The tenant of 700 acres of light land, with three barns, lately came to ask me to build him a chaff-house, and at first could not part with one of the barns for the purpose on any account. I quietly maintained my position, and subsequently converted one of the barns into a chaff-house, in which he has placed his machine, and it answers admirably. A good roomy place in which to cut hay and straw into chaff has become *as indispensable a building as the barn itself.*

We have several, I might say many, tile-yards erected and machinery at work for the manufacture of pipes and tiles for draining, but the prices are, and without greater competition still likely to remain, much higher than those we have seen mentioned by Mr. Pusey and others.

The establishment of more yards and machinery for the manufacture of pipes and tiles for draining would be a great convenience to tenants. The distance of carriage would be lessened, as well as the prices from the competition in the market, and, we believe, from their abundance and easy access, more would be used.

The removal of unnecessary hedges and pollard trees, and, in the vale, of half the timber, would enable the farmer to bring into cultivation a considerable quantity of land that is almost *waste land* in its present state. On the hills in very bleak situations belts of plantation would be useful as shelter; but some of the fences are there unnecessary, and others should be reduced and kept low and narrow, and the strips which are now waste ploughed close up to the hedge or wall, leaving a space uncultivated of not more than 2 feet wide on the average. About 4 per cent. of the land on the elevated portion of the county is occupied with fences, and it is shown by the practice of cropping that not more than 2 per cent. is required for fences. Thus by the general adoption of cropping the hedges and keeping them reduced, a gain of two in every 100 would be the result. In the vale about 8 per cent. is occupied with hedges and ditches: those may be reduced so as to occupy no more than 4½ per cent., thus gaining 3½. *This is without considering that many are*

unnecessary and should be removed altogether on the hills, and in the vale one-half might be dispensed with—let us say one-third. Thus a further gain of $1\frac{1}{2}$ per cent. in the vale may be effected; and omitting what might be gained by the removal of some fences on the hills, we have a total gain of waste land equivalent to 4 per cent., or 32,000 acres, which might be easily reclaimed and brought into cultivation, which, if arable, besides other crops, would annually produce 28,000 quarters of wheat, and which would increase the wealth of the county by at least 100,000*l.* per annum.

The labourers' cottages are not more incommodious than elsewhere, and, when rented directly from a landowner or large farmer, the rents are moderate. On many estates the cottages are let at from 30*s.* to 50*s.* a-year, each having a quarter of an acre of garden, or that quantity made up in a field allotment. But I should be inclined to find a little fault with the accommodation usually afforded for a man with a family. The cottages chiefly consist of one room and pantry below, and two small rooms upstairs, sometimes only one. This is not as it should be; Lord Sherborne and several proprietors have turned their attention to the remedy of this glaring defect. Lord St. Germans is adopting the plan of building double cottages, placed a short distance from the village street, with sitting-room, pantry, wash-house, and furnace, &c., below, and *three* bedrooms over. In this arrangement a bedroom for the man and wife is provided, and a room each for the boys and girls of their family; also, instead of field allotments, each cottage has a quarter of an acre of land attached. The cottages are more expensive than many would wish; but certainly superior accommodation is afforded, and the rents are very low. It is not desirable to have cottages too large, but where there is a family three bedrooms are requisite.

The plan of lodging and boarding young men in the farm-house has long been discontinued on most farms in Gloucestershire. The farmer is thus relieved of much trouble in providing for his men; but at the same time it is believed that society has suffered by the suspension of that wholesome moral restraint which formerly was exercised by the master over his men whilst on his premises and under his roof. After a certain hour the young and thoughtless youth is left to follow unchecked his own natural propensities, and does not fail to meet at the village ale-house every incentive to vice.

IX.—*On the Cheapest and most Effectual Mode of Repairing the Banks of Tidal Rivers flowing through Alluvial Soils.* From G. S. Poole.

To Mr. Pusey.

Sir,—Most of those who own estates abutting on rivers which flow through an alluvial district, have experienced the enormous cost of repairing the banks. As an instance of this, I may mention that a lady, who owns eight acres adjoining the River Parrett, in Somersetshire, lately told me that the rent of these eight acres, 20*l.* per annum, had for several years been spent in repairing the bank, and that, in the past year, the expenditure on the same bank had exceeded 60*l.* As this is by no means an uncommon case, I think I shall be rendering some service to persons similarly circumstanced by suggesting a plan for repairing river-banks of this description, which I have found cheap and effectual, and which is within almost every one's reach.

Some years since the agency of an extensive estate near Bridgwater, with a frontage of about two miles in length against the River Parrett, was intrusted to me, and in the first year I had to deal with a serious slip of the bank, which occurred in one of the reaches of the river. The ordinary mode of repair was adopted. Layers of thorns were placed on the surface of the mud at low water parallel with the stream, which were secured by pegs passed through the heads of two rows of piles, one on each side of the thorns; and which piles were driven into the mud to the depth of from 7 to 9 feet. A second layer of thorns, similarly secured, was placed higher up to support the towing-path. As this was not successful, it became necessary to load the thorns with many tons of stone, and to alter the position of the work. After a time the work settled, but it moved more than once afterwards, and needed occasional repair, and the collection of mud upon it was but trifling. I did not, therefore, consider this a successful mode of repair, and the expense of it frightened me. On examining other works on the river, I found that the low-water works generally, whether loaded with stones or not, were unsuccessful, and frequently stood out in the bed of the river, the tide having formed a channel between them and the bank. I further observed, that wherever there was a division between two fields with bars running down the river-bank, the bank was almost invariably gaining on the river. The cause of this was evident. The tides, which rise in this river sometimes more than 20 feet, and flow with great rapidity, hold a large quantity of mud in solution, the stream being extremely turbid, and the weeds which collect on the bars check the current of the stream, and cause a deposit to take place. I therefore determined to contrive something which

would have a similar effect, and, after trying different expedients, I at last adopted the plan of trenching in stout hedges of dead thorns from high-water mark to low-water mark, burying their lower ends 2 feet in the mud, and allowing their heads to stand up at least 5 feet above it, the higher the better. These hedges being at right angles with the stream, necessarily created a considerable obstruction to the tide, and caused a rapid deposit of mud; but, wherever the bank was steep, I found it necessary to trench in another hedge parallel with the stream and at low-water mark, connecting together the hedges that stood at right angles with the stream, in order to prevent the mud that was being deposited from dropping again into the course of the tide. The accompanying sketch will explain, perhaps better than words, the plan which I have followed:—

It is essential to the success of this plan that the thorns should be at least 7 feet in length, and that any hedge that is made parallel with the stream should be as low down the bank as possible, for, if placed on the steep side of the bank, it will frequently be unable to support the weight of mud which will accumulate upon it. I have now tried this system long enough to satisfy myself that it collects the mud more rapidly, and is infinitely cheaper, than any other system which has been tried on this river. The apparent slightness of the material, and its perishable nature, may at first sight be considered objections, but they are not so. I have never known these hedges washed away; the rapid collection of mud effectually secures them, and the only injury they are likely to receive is from a ship occasionally making a gap in them in passing up or down the river. This, however, is easily repaired. The material also will not decay before it has effected its purpose. If the hedges are put in at the right places, in the right way, and of sufficient height, a few months, and frequently a few weeks, will cover them with mud, and a hole in the bank, large enough for a schooner to lie in, will be entirely filled up.

Thorns are delivered on the bank of the river at 10*s.* per waggon-load, which contains sixty bundles. The labour of trenching them in costs 2*s.* 6*d.* a waggon-load more. It takes about a waggon-load of thorns on an average to make one hedge

from high-water mark to low-water mark; but this, of course, varies greatly. The old system of piles and stones, in addition to thorns, was infinitely more expensive and less effective; and, at the same time, the piles were seldom of sufficient length to be of any service as a support to the bank, whilst they exposed the landowner to the risk of an action being brought against him for the injury which they frequently did to the shipping.

I have the honour to be, Sir,

Your obedient servant,

G. S. Poole.

Bridgewater, December 5, 1848.

X.—*On Dry Warping at Hatfield Chase.* By Wm. Edwards.

The interest which attaches to the improvements of peat moors, and the peculiar importance of the process I am about to describe, induces me to lay before the Society a more full description of it than the incidental mention made of it by Mr. Pusey, in his paper on Lincolnshire Farming.—I allude to the improvements of Hatfield Chase, in Yorkshire, by what may, not inaptly, be called "dry warping."

The ordinary process of "warping," as practised on the banks of our tidal rivers, is well known. It is only applicable to situations where the muddy water can be turned on the land, and readily drained off after it has deposited its alluvial matter.

"Dry-warping" is the spreading over land that deposit or other soil, to a depth of 6, 8, or 9 inches, and thus converting barren or inferior into fertile land, ready for immediate cropping.

It is obvious that, to do this economically, a considerable supply of the intended covering must be at hand; and though, perhaps, few estates in England may possess the peculiar advantages in this respect of Hatfield Chase, there are very numerous situations where the process may be advantageously adopted; and in Ireland it may be applied on a great scale, under conditions in every respect as good as at Hatfield. Hence the importance of drawing the attention of agriculturists in this country, and of the landholders of Ireland, to a system, which Mr. Pusey very truly describes as converting "the bog of Allan into the vale of Aylesbury or of White Horse."

Hatfield Chase is a peat moor of about 4000 acres, lying above the level of the neighbouring corn-lands. An Act for enclosing the moor was obtained about forty years ago, though for what object, at the time, it is not easy to see, as no one could have then anticipated the possibility of making the hitherto impassable mo-

rass of any value. By the public and private enclosure drains it became however gradually firm land, and the existence of an old river-course—that of the tidal river Thorne, or Idle, whose waters 200 years ago had taken a new channel—was remembered, and Mr. Hatfield Gossip, of Hatfield Hall, who owned a considerable part of the moor, conjectured that this old course would contain an immense mine of the mellowed and rich alluvium, deposited by the tides from the Trent and Humber. He conceived the idea of covering the whole moor with this alluvium: and to this idea, and to his determined perseverance and skill in carrying it out, we are indebted for the practical exposition of the advantages of *dry-warping*.

The process pursued by him is as follows:—A railroad is carried from the pit (or excavation into the alluvial deposit) over the moor to the part to be improved. Here branch railroads, formed in the separate pieces of framework, are laid down right and left from the main line. A stationary engine draws up from the pit the loaded waggons, which are then taken by a locomotive engine along the main line, and passed by the branches to the spot; here the waggons are tilted over, and the soil spread to a depth of 6 or 8 inches. When the moor, for 7 to 10 yards on each side of the branch, is covered, the rail is removed by a machine traversing the rails, and which takes up the separate pieces and deposits them in a fresh line with the greatest expedition and facility, and thus, as Mr. Pusey remarks, "you see a sheet of firm and fruitful soil steadily spreading over the hopeless quagmire:" but the latter expression is hardly applicable, for no *quagmire* would admit of the passage over it of heavy locomotives, and the long and complete drainage of the moor has solidified the whole sufficiently to bear any load. Were it otherwise, a system of light waggons and rails and Welsh ponies may be brought into operation, and indeed in most cases this will be more economical, and under greater control. The moor is thus covered at the rate of 8 or 10 acres a day with a clean and friable soil, absolutely ready for seed day by day, as fast as it is levelled; for the fine alluvium does not require any previous exposure to the atmosphere. The rapidity with which the barren waste is converted into rich land, actually cropped, is a remarkable and most interesting feature in the operation.

The advantages of a well-drained substratum of peat have been long appreciated for grass-crops. Here the fresh coating of rich soil produces a slow decomposition of the old vegetable covering of the peat, as well, perhaps, as of the peat itself; and the roots of the grass or other crop, striking deep into these, always find moisture and nutriment. The effect is, that most astonishing crops of clover, turnips, and particularly beans, have been grown on the

newly warped land, and it has been found that the grass is green in the driest seasons, and possesses peculiar milking and feeding qualities. Thus it is attested that 100 acres of it fattened, between Blythe fair (16th of May) and the 25th of August, 95 beasts on an average, 600 sheep, and 250 lambs; after that, to the 5th of September, 400 old sheep; and the pasture was left very good.

It is not necessary to give more in detail the process for conveying the soil or warp from the pit to the moor. The operation is in itself of the simplest description. The scale on which it is to be carried out alone will render some skill and engineering knowledge necessary, to be varied in every locality; and unless where a locomotive is thought desirable, it is essentially a "farmer's job." Neither must we consider it as necessarily to be confined to the peat moor, or to a tidal deposit. Wherever any substitute for this latter can be found in quantity, and in the vicinity of barren or valueless land, the system may be pursued to national and individual benefit. In the neighbourhood of the Trent and Humber there are thousands of acres now of little account; and not far off, beds of tidal alluvium, as little considered by, or perhaps known to, the farmers about, as that at Hatfield before Mr. Gossip developed it. A tract of about 4000 acres, called Thorne Waste, a few miles off, is about to be "dry-warped" upon Mr. Gossip's plans, but the warp is not on the spot, and will be brought by the Axholme Railway a considerable distance. Still it has been considered by the farmers there sufficiently desirable to justify an Act of Parliament (11 & 12 Vict. c. 150) for empowering them to enclose, drain, and warp it, even at an expense of 35*l.* per acre.

There is little question that, as the system becomes extended and developed, the cost of dry-warping will be reduced. Mr. Gossip's costs 15*l.* per acre near the pit; but the average of the moor will be 18*l.*, including plant, on account of the extended carriage, &c. Tenants have been always readily found to pay 2*l.* per acre for the newly warped land, and an offer, with security, is now under consideration for 2*l.* per acre for the whole moor, on a ten years' lease.

The peat retains its moisture in dry seasons, even when deeply drained, but it is expected that great advantages will be derived from subirrigation. The warp-pit, which will extend over nearly 50 acres, forms a reservoir from which the deep and divisional drains may be filled at pleasure. The subject of subirrigation is of an importance great in itself, and increasing with the increase of deep draining, but it is only incidental to the object of this communication.

Mr. Gossip proposes to lay the whole moor down in grass, and divide it by quick-fences into 100-acre fields. It is found that quickset thrives most luxuriantly on the warped land, and thus a

sufficient protection will be rapidly obtained for the Cheviots and hardy Scotch stock; and that gentleman may, with reason, pride himself as the instrument for converting 4000 acres of barren peat into one of the finest grazing-farms in England; and, as the practical introducer of a system already applied to another similar-sized tract, and applicable more generally than at present thought of, to the material increase of the agricultural resources of our country. As to Hatfield Chase, it is doubtful whether any equal extent can be found in the celebrated vales mentioned by Mr. Pusey, to compete in produce and actual fertility with this once "hopeless quagmire."

XI.—*Destruction of the Wire-Worm.* From J. M. H. Charnock.

To the Secretary.

Dear Sir,—Without any purpose of competing for the prize offered by the Society, but thinking it possible at the same time that a brief account of a very simple and efficacious plan for the destruction of the wire-worm may either tend to confirm the practical value of some of the Essays that may be written on the subject, or by its publication benefit the agricultural community, I beg permission to lay the few necessary particulars before the Journal Committee.

That I may not appear to assume what, in this, I have no title to, viz., the merit either in theory or practice of the plan, I must state that it was communicated to me a few days ago by my relation, Mr. Charles Charnock, of Holmfield House, who himself received it from Sir William Cooke. Some few years after his entry on his farm, Mr. C. was complaining, in the presence of Sir William, of the injury his crops had sustained from wire-worm, and lamenting that there was no known way of destroying them. Sir William then informed him that he had heard of and adopted a plan which had proved perfectly effective; and which Mr. C. subsequently followed with the same success.

In lieu of the ordinary top-dressing with rape-dust, apply to the land, and plough or harrow well in, 5 cwt. per acre of rape-*cake* crushed into lumps of about the size of half-inch ground bones, and the result will be, that the wire-worms will congregate on these lumps of cake, devouring them with such avidity as to become glutted, and perish either from repletion, or from the peculiar properties of the rape, or from the combined effects of the two. Rape-*dust* will *not* answer the purpose, because it presents no surface upon which the worms can fix themselves, and

no substance into which they can eat their way. Perceiving that a satisfactory result was being attained in the first field to which the cake was applied, Mr. Charnock took up and examined many of the lumps, and found them full of the defunct and expiring enemy. The practice was, of course, followed throughout the farm where the worm prevailed, until in a year or two the land was perfectly freed, and that without any recurrence of the evil.

Mr. C. has also on several occasions since had recourse to the same means for preserving his carnations (which are very liable to be attacked by the wire-worm), and he has invariably witnessed the same satisfactory result.

The plan is so simple, and apparently so efficacious, that I need not dilate further upon it than to remind those who may be disposed to try it, that whilst they may hope to destroy the worm they will certainly add a rich fertilizer to their land at a reasonable cost.

It should perhaps be mentioned, that the land to which Mr. C. applied the remedy is a dry soil on the magnesian limestone, and I believe Sir W. Cooke's was the same; but I see no reason for supposing that it would not be equally efficacious in other soils.—I have the honour to be, dear Sir, yours truly,

J. M. H. Charnock.

York, February 28, 1850.

XII.—*On the proper Quantity of Seed for Wheat.* By R. Birch Wolfe.

In 1848 I communicated the result of an experiment made by me on thin and thick sowing of wheat, which was published last year in the Journal of the Royal Agricultural Society; and from the statements I then made, it appeared that 7 pecks of seed, drilled at 7 inches apart, gave a produce of nearly a quarter an acre more than 6 pecks drilled at 9 inches, the cultivation and land being equal.

As it was impossible to arrive at any satisfactory conclusion from a single experiment, I made a further trial last year, and, having now accurately ascertained the results, I give them, that if thought of any use they may appear in a future number of the Society's Journal. The land marked out for the experiment consisted of 3 acres lying together in a field of 16 acres, and divided into 4 plots of 3 roods each; the cultivation was exactly alike in each case, and the soil heavy clay in good heart; the seed Spalding wheat. I may add that the whole of my land is formed into *flat* stetches 7 feet 2 inches wide, which are exactly covered by the drill,

harrows, and rollers, all made with double shafts, and the horses walk between the stetches.

EXPERIMENT.

Width of Drills in Inches.	Seed at rate per Acre.	Produce in Sheaves.	Produce in Grain from the 3 Roods.	Produce at rate per Acre.	lbs. Weight per Bushel.
			Qrs. R. P.	Qrs. R. P.	
9	5 pecks.	689	4 0 0	5 2 2	62½
6½	7 do.	665	4 0 0	5 2 2	62½
8	6 do.	681	4 0 3	5 3 2	63
Dibbled and Dropped by Hand at 8 inches	6 do.	692	4 1 0	5 4 0	61½

It will be seen by the above statement that the produce from each parcel of land was very nearly the same—that which was dibbled failed most in plant, but tillered well, and yielded rather more than the rest, but in proportion as the plant was thin, so was the grain coarse and light.

From the frequent observations that I have made, and judging from both the above experiments, I have come to the conclusion that, taking the average of seasons and all other circumstances into account, there is great risk of loss in drilling wheat in such land as mine, at a distance of more than 8 inches, and with less seed than 6 pecks per acre. In heavy land, of average quality, well drained, and in good heart as mine is, the above quantity of seed (6 pecks) and intervals (8 inches) will, I think, be found the safest and most productive, at the same time it is very probable that less seed and greater intervals might answer as well or better in lighter land of superior quality, supposing the system of cultivation to be carried out upon the most approved principles.

I have this year acted upon the conclusion I have come to, and drilled all my wheat (about 80 acres) with 6 pecks of seed, and at 8 inches apart, and up to this time I am perfectly satisfied with the promise.

R. BIRCH WOLFE.

Wood Hall, near Newport, Essex,
February, 1850.

XIII.—*Farm-Buildings.* From Mr. Thompson.

To Mr. Pusey.

My dear Sir,—As one of the judges of the Essays on Farm Buildings, and with the full concurrence of Lord Portman, the other judge, I send you a few remarks on the reports and plans submitted to us.

You will, I have no doubt, recollect remarking that never since the formation of the Society were so many good reports sent in for one prize, and it will probably be satisfactory to the unsuccessful candidates that this fact should be publicly stated. My principal reason, however, for now addressing you, is the conviction that on a subject where so much difference of opinion prevails, as on the best form of farm buildings, it would be satisfactory to the members of the Society to know on what principle the judges proceeded in adjudicating on this large and meritorious class of reports.

The first point which it was necessary for the judges to bear in mind was, that the object in giving a prize of this kind was to obtain plans which should be as *generally useful* as possible. This at once drew a broad line of distinction between the course to be followed by the judges, and that which would be adopted by any one who was selecting a plan of farm buildings for his own use. In such a case the precise kind and amount of accommodation required could be ascertained in the first instance, and the plan which provided it in the most compact and economical manner would be sure to carry the day; whereas the judges were fully aware that no one plan could possibly meet the wants of the great variety of soils, climates, and systems which prevail in the different districts of the kingdom, and it was consequently their object to select for the prize that plan which was not only good in itself, but which was most capable of extensive alteration without sacrificing its general plan of arrangement, and which contained the greatest number of useful suggestions that would admit of being separately introduced by those who wished to make some addition to existing buildings, or who, from any other cause, did not choose to adopt the prize-plan as a whole.

Another point which they kept prominently in view was, that no plan would be generally satisfactory which did not provide for the introduction of the latest improvements in farm management. There are doubtless many who are either not convinced of the advantage of thrashing by steam, box-feeding, and other modern practices, or, at any rate, who are not prepared to introduce them on their own farms at the present moment; but there are probably very few of those who are about to lay out any considerable sum

in farm buildings, who would be satisfied with any plan which was not capable of being adapted to such a system whenever it might be thought desirable to commence it.

Having thus briefly pointed out the general views entertained by the judges of the proper ground to be taken in making their award, I will proceed to show their application to the Essays now published, more especially to that selected for the prize.

One of the first points which will strike every one conversant with farm buildings is, that in all the plans now published the old method of building round a rectangular area, and using the enclosure as a straw-yard, has been either given up or very much modified. The cause of this change is obvious: so long as farm horses were fed on unground corn and uncut hay or straw, it was only necessary that the stable should be conveniently placed with respect to the barn and the hay-stack; and when cattle were wintered chiefly on straw, which was supplied to them direct from the barn door, the old fashioned square yard, surrounded by buildings, was probably the best that could have been adopted, inasmuch as it took up the least room and was the cheapest mode of supplying shelter to the cattle.

By degrees, however, it was discovered that if the horse corn were ground and the fodder cut into chaff, not only was the food consumed with less waste, and more perfectly digested, but the labour of mastication was materially reduced, and the animal power economized and reserved for more profitable employment.

The same principle holds good in the feeding of cattle, and of late it has been carried a step farther, and heat has been applied either to steam or scald the chaff with linseed gruel and meal, with the view of rendering the nourishing ingredients of the food more perfectly digestible, and of supplying artificially the heat which must otherwise be produced by a waste of the animal tissue.

It is unnecessary to pursue the subject further, as it would be easy to show that in other branches of farm management the same principle is being carried out, and it may be stated generally:—That it is found profitable to call in the aid of machinery, and to make the business of a farm approximate more closely to that of a manufactory.

The necessary consequence of this change of system is a great increase of intercommunication between the different buildings of a farm. The straw which formerly went from the flail to the rack now goes in the first instance to the chaff-cutter, from thence to the boiling-house, and lastly to the stable or cattle-shed, so that it is becoming more and more important that the straw-barn, the chaff-house, the cooking apparatus, and the live stock, should be as near one another as possible. Hence one of the indispen-

sable requisites of a modern farm-yard is great facility of communication, especially between the buildings just named, and a single glance at the prize, or the commended, plan, will show how much easier of access buildings are when placed in a paved or macadamized yard, than when the whole interior is occupied as a straw-yard. Any inhabitant of a town who had frequent intercourse with his opposite neighbour would know how to appreciate the difference between crossing a square and crossing a street, and in the case of a farm-yard there is the additional inconvenience of crossing the midden.

Another point of importance is, that the straw-barn should be as central as possible. The great inconvenience of moving straw to any distance, especially on a windy day, is so well known, that it is quite unnecessary to offer any proof under this head. In all the plans now published the barn is tolerably well placed: the Prize Essay, however, and Mr. Hudson's, carry it a step further than the rest, and place the straw-barn, where assuredly it ought to be, in the very centre of all the stock.

These main points having been provided for, the next feature of importance is, that the buildings should be conveniently grouped together. An excellent specimen of convenient arrangement is seen in the prize-plan, where the stable will be found surrounded by everything pertaining to the food or the work of the horses. At one end is the straw-barn and the steaming-house; at one side is the blacksmith's shop, while the sheds for large and small implements are immediately adjoining, so that whatever the work may be for which the horse is taken out of the stable, the cart, the plough, or the drill is on the spot, and if an implement requires repair, both carpenter and smith are close at hand. It would probably be better that the small implement-shed should be made to change places with the smith's and carpenter's shops, so that the forge should be further from the stackyard; with this trifling alteration the arrangement of this yard is very complete; and the office for the farmer at the entrance-gate ought not to be passed over in silence, as it would obviate the necessity of many an adjournment to the house, and many a handing down and dusting of "master's desk," besides saving much valuable time that is lost in hunting for bills and other papers that are seldom forthcoming when wanted.

In the few prefatory remarks with which this letter commenced, it was stated that capability of adaptation to different systems of farming was essentially requisite in a prize plan. It will be necessary now to show how far the one which has received the prize fulfils this condition. Commencing with the barn, it has been already shown that the straw-barn is in its right place: if a corn-barn were required the building would have to be

extended into the stackyard to the desired length: if thrashing by horse-power were preferred to thrashing by steam, the horse-walk would occupy the space now appropriated to boiler and engine-house. On entering the yard the same facility for re-arrangement will be found. Beyond the stable a considerable building is provided for tying up sheep. This would not be generally required, and if it were dispensed with, and the yard for young stock enlarged, by moving the partition-wall somewhat nearer the stable, provision would be made for the accommodation of the additional store-cattle which might be kept by those who did not consume their turnips with sheep.

If the occupier preferred a stable of the ordinary kind in lieu of boxes, no further change would be required than to place the stable lengthwise instead of across the yard, so that one end would abut upon the yard for young stock, and have a door opening into it, for the litter to be carried out in the ordinary way. Again, if the buildings were intended for a farm of large size the accommodation for feeding cattle might be readily increased by extending the double range of boxes right and left, at the end of the present row, and an additional turnip-house about the centre of the new range would make that a convenient arrangement; perhaps even a turnip-house so placed would be a useful addition to the present plan, as the turnips would be in a good position both for the fat and store stock, and the space now occupied by the root-house might be advantageously disposed of as a depôt for straw on the ground-floor, which few farmers would like to be without. If it were thought desirable not to change the place of the root-store, the straw-house might still be provided by giving up the first two boxes for that purpose. Some difference of opinion yet exists as to the comparative advantages of feeding cattle in stalls or boxes; if the former be preferred, and the ground now occupied by boxes were fitted up with stalls, nearly three times as many cattle could be accommodated—the manure would then be daily carried in a truck on the tramway, or wheeled along an ordinary causeway, either to be at once made into compost by admixture with soil, ashes, &c. (a practice which cannot be too highly commended), or to be thrown out by a side door into the adjoining yard. Should a plan be required for a mixed arable and dairy-farm, the present cattle-boxes would make an admirable cow-house with stalls for fifty cows; and as dairy-farms are usually small, the second yard, now chiefly devoted to cows and pigs, might probably be dispensed with altogether, with the exception of the dairy and pigsties, which would form proper appendages to the yard of the farm-house, the site of which is indicated in the plan.

A sample has now been given of the almost unlimited capability

of alteration possessed by the prize plan, without destroying its leading features; the same may, to a great extent, be said of the commended plan. There are, however, some points in the latter (perhaps it should be said in all the plans) which are not approved by the judges, and as it is an invidious course to point out faults in plans which contain so much that is worthy of praise, the same end will probably be attained in a more agreeable way to all parties by stating in general terms what the judges think ought to be provided in a plan of farm-buildings, leaving the reader to make the application for himself.

In general terms, then, the main objects contemplated in making farm buildings are, 1st. To make convenient arrangements for thrashing and preparing for market the grain crops.

2nd. To provide accommodation for the live stock.

On the first head little need be said; the position of the straw-barn has already been spoken of, and provided that the corn-barn be conveniently arranged and proper facilities afforded for the employment of either steam or horse power, the designer of the plan will have done his part; the rest will depend on the judgment of the occupier in selecting his thrashing-machine and other barn implements.

The accommodation for stock is a much more difficult subject, and in a brief sketch of what is required it will be necessary to keep constantly in mind, that in the housing of live stock and the preparation of their food, the first object should be to enable the animals to derive the greatest possible benefit from their food, and the second, to preserve the manure from deterioration or waste. The food annually consumed on every farm by the horses and other live stock would, if its money value were stated, amount to such a sum as to impress every farmer with the importance of economizing its use; and the difference between the value of a substance for feeding purposes and its value when in a state in which it can only be used as manure, is so considerable, that it is very bad policy to be lavish in the supply of food because what is left or wasted makes capital manure. The value of linseed-cake for manure is (as far as can be ascertained) about the same as that of rape-cake; but the former has an additional * value for feeding, which makes it about 50 or 60 per cent. dearer than the latter; any linseed-cake, however, which is not digested by the animal, and remains in the manure, is worth no more than an equal quantity of rape-cake, or, in other words, it has lost more than one-

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* I continue to find that for *sheep* rape-cake is of equal value in feeding with linseed-cake. Those who try it, however, should be cautioned, that sometimes a sample of rape-cake occurs which sheep do not like. It is yellow and hot. Old rape-cake they will eat as well as linseed-cake. Cattle will only eat rape-cake mixed half and half with linseed-cake.—Ph. Pusey.

third of its previous value. Hence any arrangement by which one animal has more food than he can digest, and another less than his share, is on both accounts a source of loss to the owner, and if the stock are exposed to the cold in winter, a further loss takes place; but if by grinding, steaming, or other preparation of the food, and by the use of warm boxes or stalls, in which each animal receives its allotted portion, more of the food is converted into fat and flesh, and less remains in the manure, a saving is effected not only in the more uniform thriving of the stock and the smaller portion of food which is expended in maintaining the animal heat, but also in the difference in value between a feeding and a manuring substance, the proportion between which has been pointed out in the case of linseed-cake, but which there are as yet no data for calculating in the case of corn, hay, or roots. Again, the undigested food left in the manure is subject to further depreciation before it is applied to the land. The better the manure the more liable it is to heat, and the more it has been heated, the more it suffers from rain. How then is it to be prevented from over-heating? Compression is the readiest and most efficient way of accomplishing it, and this is obtained most perfectly in boxes, in which the manure is solid enough to prevent undue fermentation, and is also protected from rain. If straw is scarce, and stalls for feeding cattle be preferred, the labour of cutting the litter and of wheeling away the soiled part daily to mix with earth, is amply repaid in the perfect preservation of the manure which is thus obtained.

The advantages of feeding cattle in stalls and boxes have been so prominently put forward of late as to lead to the proposal to dispense with straw-yards altogether. This is running from one extreme to another. It has certainly been proved both scientifically and practically that warmth is to a certain extent a substitute for food, and during winter fattening cattle can scarcely be kept too warm consistently with good ventilation; but it would be unwise to tender young cattle or cattle of any sort that are not making up for the butcher, and are intended for summer grazing. Young animals also require a certain amount of exercise, which is conducive to healthy growth, and probably no arrangement is superior to small, well-sheltered open yards for young stock.

In ordinary farmyards manure is much injured by rain-water, and to obviate this it is suggested that covered depôts should be provided where it may be deposited till wanted. The objection to covered manure pits is, the lightness of the manure and its consequent tendency to heat itself dry with very great loss of ammonia. It certainly may be watered from a pump or tank, but this would only increase the fermentation so long as the heap was light, and to meet this difficulty it has been suggested that it should be frequently carted over. It is certainly *possible* by carting or some other mecha-

nical means to give sufficient solidity to prevent mischief, but when the trouble and inconvenience of carting over a partly decomposed heap, and also the probability of its being neglected in busy seasons, are taken into account, it will probably be found that in the majority of cases covered manure-pits would do more harm than good. Well-spouted farm-yards, in which the manure is allowed to accumulate through the winter and trodden firm by being well stocked—heaps in the field, well covered with soil—and loose boxes for fat cattle and farm-horses, will enable a farmer to keep his manure in first-rate condition; and the importance of these and other similar arrangements cannot be too often or too strongly insisted on.

The foregoing remarks lead to the following conclusions:—

1. That the communication between the different buildings of a farm should be by means of a paved or macadamized yard, and not across a straw-fold.

2. That provision should be made for the introduction of loose boxes or stalls for fattening cattle.

3. That small open yards with covered sheds should be provided for young or store cattle.

4. That covered manure-pits are not generally advisable.

Hoping that the importance of the subject will justify the length of this letter,

Believe me yours truly,

H. S. Thompson.

Moat Hall, June, 1850.

XIV.—*Essay on the Construction of Farm-Buildings.* By Sir Thomas Tancred, Bart.

Prize Essay.

A well-arranged set of farm-buildings is a rare exception to the general rule. Those which are commonly seen have been erected and altered piecemeal, to suit the immediate wants of different tenants, at the least present outlay, and with little reference to any general and uniform plan. The progressive changes, too, in farm management, consequent on improvements in agriculture, have rendered many buildings, which may have been well contrived when first erected, now inappropriate. Whatever the cause, the result too often is a chaos of confused erections scattered over a wide space, with no systematic connexion between the parts, entailing, on the one hand, much useless expense on the landlord in repairs, and, on the other, great waste of time and labour, with a difficulty of proper superintendence, on the occupier. Some-

times huge barns will be seen standing alone, or with a cattle-shed attached, at wide intervals over a farm, hardly to be approached with wheels on account of the bad roads for several months in the year, by which, though there may be an apparent saving from shortening the carriage at certain times of the year, it will be found, on the whole, that time and labour is lost, and that an opportunity for peculation and idleness is offered to the workmen, to say nothing of the cost of repairs, &c. Another crying evil in most farm-buildings is, that the manure made in them is considerably reduced in value by being exposed in wide open yards to the rain, sun, and wind, by which the more soluble and volatile parts are wasted, and a filthy state of the yards is always maintained. We have been sometimes tempted to ask a farmer, from whose yards the fertilising streams of dark liquor were flowing into the ditches or horse-pond, whether he was fond of strong tea? The answer being generally in the affirmative, the next question would be, whether he thought it would be a good plan to leave the teapot under the urn and to set the water running through it before he helped himself? The land finds this washed dung nearly as valueless as he would his tea-leaves treated as above.

From these various defects there results a sacrifice of labour and men's time, whether in getting the corn into the barn, in disposing of the straw after it is thrashed; in watering and feeding the animals; and, in short, in almost every operation about the homestead.

Turning from the exterior aspect of the buildings, it is too often found that the construction of the interior of each is as faulty as the exterior plan of the whole. Horses are deprived of their health or of eye-sight by the ammoniacal exhalations in close and pestilential stables; cattle are plastered over with their own excrements, and a waste of food is caused by attempting to fatten animals under circumstances in which most of what they consume is appropriated to keeping up the necessary animal warmth. Diseases are caused in young stock by exposure to wet and cold, by which numbers perish, or at least their after-growth is stunted and their value much deteriorated.

Now in place of this too common state of things it must evidently be of the highest importance, in order to make the most of a farm, that the buildings should be concentrated, each part adjoining as nearly as possible those with which it is most in connexion in the routine of daily work, that thus time and hands may be economised, and a ready superintendence over every part possible; so that, in short, the several products of the farm, whether grain, cattle or manure, may be produced in the greatest excellence and within the shortest period. If we observe the admirable arrangements for economising labour displayed in most

manufactories, on board ships, &c., it will be evident that farmers are placed in a very disadvantageous position in comparison. It has been stated that a Manchester manufacturer who should make his hands ascend by *stairs* to the various work-rooms, instead of taking them up by the *steam-hoist,* would be ruined!

When we turn from these general considerations to endeavour to devise a plan which shall combine all the requisites in farm-buildings in the most advantageous manner, we are met on the threshold by this difficulty, viz., that no plan can be given which shall be the best possible for several different localities. Each site requires modifications peculiar to itself; for instance, whether the ground be sloping or horizontal, whether water-power can be made available, whereabouts the farm-house or the principal road may be situated. Again, the systems of farming for which the buildings must be adapted vary considerably in different districts. In one dairy-produce and pigs form a chief item; in another sheep or lean stock are reared; in another the feeding of cattle for market is more attended to; in others cider is manufactured, and cellars, apple-rooms, mills, &c., are required; or hops are grown, and require kilns, oast houses, packing and cooling rooms; or flax is to be steeped, stored, broken, and scutched; or sundry sorts of seeds are grown, &c. These various considerations make it impossible to furnish a plan which shall be abstractedly the best for all situations; the utmost that can be done is to develop such *general principles* as should always be kept in view in the arrangement and connexion of the several parts of such establishments, one portion or the other being relatively enlarged, or contracted, or dispensed with, as may be found requisite for any particular locality. Another difficulty is that farming is a progressive art, and different practices prevail in the management of stock, in the implements employed and in the power applied to machinery in different parts of the kingdom, so that what might be thought a very complete arrangement in Hampshire would not suit the practice of a farmer in Berwickshire, and *vice versâ.* In reference to this latter difficulty, the writer deems it useless to devise buildings adapted to implements and practices condemned by the most advanced agriculturists, and therefore he has taken for granted that *barns* for housing grain previous to thrashing it are needless, that *steam* or *water* power is employed to drive machinery, that *box-feeding* of cattle, sheep, &c. on steamed food, with litter cut into chaff, is the best system for the production of meat and manure, and that *carts* for all purposes should be adopted to the exclusion of waggons. It is with reference to these arrangements that the accompanying plans are proposed, which admit of enlargement or contraction by a simple elongation or shortening of their several parts, ac-

cording to the size of the holding—the present scale being adapted for a farm, chiefly arable, of about 300 acres, according to the specification in the Society's programme.

Taking a general view of the arrangements proposed, it is intended that a space to the north of the buildings should be occupied by the stack-yard, where the year's crop of all kinds shall be stored; the grain on staddles, arranged in lines, and the hay and roots as conveniently as possible, the latter in long heaps as shot from the carts and covered with straw. Between the lines of stacks rails or tram-ways are laid of such a gauge (say 3 feet) that the cart-wheels shall travel easily on each side of the rails; and for the convenience of stacking and removing the corn, the staddles may stand in an excavation their own depth below the level of the roads between.

The stack-yard thus containing the raw material out of which the chief products of the farm (viz., the grain, the fat meat, and the manure) are to be obtained, we convey the sheaves on a truck along the rails to the elevator, which raises them to the threshing-machine, the grain being delivered below into sacks ready dressed for market and the straw carried forwards on the upper story into the straw-barn. On this upper floor are, 1st, the chaff-cutter which cuts up the straw into food or litter; 2nd, a linseed and grain crusher; 3rd, a cake-breaker; 4th, a pair of millstones; all delivering their work into receptacles on the ground-floor. At this central part of the buildings on the ground floor is the *kitchen*, as it may be termed, where the food thus prepared, and the roots, cabbages, &c. from the root-store adjoining, may be cooked by waste steam from the engine, or by a boiler in the kitchen, and hence distributed with the least trouble through the several houses of live stock which converge towards this point, viz., straight forwards to the fatting cattle—on the left to the horses and sheep—on the right to the pigs and milch cows. The animals whose food is most bulky, or requires most preparation, are placed nearest to the cooking department, the sheep and young stock, milch cows, &c., much of whose food will be merely sliced or given without preparation, being placed furthest off. The part of the food not assimilated by the animals, and which has been collected, together with the litter, under cover in the boxes, is conveyed away through the further extremity of the yards, being either deposited for a time under cover in the manure depôt, or at once carted on the land. The water from the higher roofs inside the yards is conveyed by spouts into tanks conveniently situated for supplying the different animals, the dairy, &c. Thus the chief part of the premises is kept quite clean and neat, no litter, dung, or drainings of dung-heaps being seen, excepting towards the further extremity, where the young stock, young pigs,

lambing ewes, &c. may be allowed more liberty than the other animals; but even here this is not necessary, as proved by Mr. Huxtable, whose calves and young pigs are kept in sheds from the first.

In the general view of the plan of the homestead to which our attention is now confined, we may observe that on the left hand on entering is the *power* employed on the farm, viz., the engine and horses, with the implements to which they are harnessed, and the workshops in which repairs to these are executed; in the central parts and to the right hand are the grain, the fatting beasts, the dairy—near the cows, pigs, &c.; beyond are the open sheds and yards appropriated to growing animals, and to which the litter can be readily supplied from the straw-barn. At one entrance to the premises there is a weighing-machine connected with an office, where the weight of everything passing in or out of the buildings may be registered, as grain, animals, coals, manure, &c. The whole is protected from the north, north-west, and north-east by the high buildings which contain the granary, thrashing-floor, dairy, gig-house, &c., whilst the east and west winds are shut out by surrounding buildings, which are lowest towards the south. Indeed the low sheds placed on the south face might be dispensed with, and the inclosure made on that side by posts and rails, or by a low wall.

It has thus been attempted to place the buildings in that order which a consideration of the dependence of one on another seemed to point out as most advisable; and we may now proceed to a more detailed description of the several parts, mentioning, under each, examples of their successful application.

Stackyard (*a*)*.—The stackyard to the north contains all the corn and straw produced on the farm, stacked on staddles of either stone or cast-iron, with wood or iron framing. If wooden framing is used with cast-iron uprights, of which the first cost is about the same as stone (only that iron is of more value second-hand), the iron-work will cost about 50*s.*, and the wood and labour about as much—altogether 5*l.* each staddle. They should be made of such a size (say to hold about 25 quarters of grain each, when straw is of average quantity), as that the machine may thrash out one or two entire stacks a-day, according to its power; so that a stack may not be left unprotected during the night, and that the hands at the machine may be kept on at one job throughout the day, and so that once getting up the steam may serve for a whole day's work. Suppose 150 acres of corn are grown at 5 quarters to the acre, 750 quarters will require 30 staddles, or 5 rows, of 6 in each row, as drawn on the plan. In

* The small letters refer to those which distinguish different parts on the plans.

the middle of the roads, between the rows of stacks, may be laid tram-ways, along which a lad can wheel the sheaves under the roof to the sheaf elevator, without the employment of carts and horses. For greater convenience in making the stacks and taking them down, they are sometimes placed in an excavation, so that the bottoms of the stacks are on a level with the surface of the road. This arrangement may be seen at West Lambrook farm, belonging to Lord Portman, under the able management of his Lordship's steward, Mr. Parsons, to whose mechanical genius we are also indebted for the plan of the sheaf elevator here described, and some other parts of the machinery. The railway to convey the sheaves to the machine is seen in use at Mr. Morton's farm, on Lord Ducie's estate at Whitfield, and is intended to be used at the Royal Agricultural College, whence the plan of the staddles is taken.

Threshing House (*d*).—The sheaves, being untied, are laid on the elevator, which is composed of a number of boards jointed together at their edges by iron staples, which are caught by arms on spindles above and at the bottom, and carried round in an endless series. The untied sheaves—being laid on projections like shelves, formed to receive them, on the exterior of this sort of jointed web—ascend, and are successively delivered into the machine above stairs, which thrashes them, the corn dropping down through the winnowing machine below, whence it is again taken up by the corn elevator and delivered into the separator, whence it passes into four sacks suspended beneath, containing the various qualities—1, seeds of weeds and refuse; 2, tail corn; 3 and 4, marketable samples. By means of the straw-rake, which consists of several rows of wooden teeth fixed on an endless web, the straw is raked forwards into the straw-barn, being drawn over another web travelling in an opposite direction, which carries back to the winnower any grains which may have escaped in the straw. The chaff is blown forwards by the winnower into a chaff-house below, where it serves for litter, the dust mixed with it rendering it unwholesome for horse feed, for which it is sometimes improperly used.

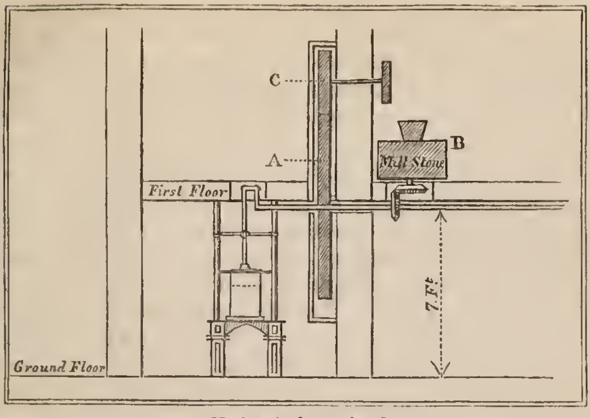
For the straw-rake the writer can refer to West Lambrook farm, mentioned above; for the rest of the arrangement he may instance the Royal Agricultural College at Cirencester. The separator, acting on the same principle as the flour-dresser, is an invention of Mr. Clyburn, of Uley.

Straw-barn, Granary, &c. (*d, e, p, q*).—The straw, being thus delivered into the straw-barn, may be either raked away by women to the farther end for future use, or be immediately cut up into short chaff for feeding, or into a longer length for litter—the first falling through the trapdoor straight into the bin below

the latter being conveyed obliquely by a spout to the chaff-house for litter on one side. The sacks of grain can be either loaded into carts directly from the side-door below stairs, or may be hoisted up through a trapdoor by a hoist attached to the machinery, as in a mill, to be either placed in the granary (*c*), or, if moist, to be spread on the floor of the drying-room (*b*), which is over the boiler, the engine flue passing through it, and being also heated by steam pipes from the boiler carried under the floor, as is seen at West Lambrook. The horse-corn may be stored in the horse-corn loft, in which is a hopper, which delivers the corn by a spout into the bin below, of which the horse-feeder may have his key, as well as of the corn-loft. In reference to this subject, it is recommended to have all locks made of a set, so that the farmer may have a master-key which will open all the locks, whilst each man has a key which will open only its own lock. Oil-cake, linseed, beans, barley, and other things to be crushed by machinery, or ground by the mill-stones, may be stowed in the straw-barn, as also the hay which is to be cut into chaff. The best machines for these purposes will be easily ascertained by a reference to the Reports on Implements which have been shown at the meetings of the Royal Agricultural Society in the Journal. It may be mentioned that the chaff-cutter with a spiral knife, invented by Clyburn, seems well adapted to steam power, being the only one, it is believed, in which the cutting instrument is *constantly in contact* with the material to be cut, and thus it works regularly without blows and jerks. This instrument is the one employed in extensive works at Chalford in Gloucestershire, where paper is manufactured from straw, and where immense quantities are cut up by it into chaff daily.

Engine and Boiler House (*b*, *c*).—The machinery above described, to which may be added, if required, a bone-mill, pumps, or a circular saw, is supposed to be driven by a six-horse power engine, with plenty of boiler room, the fly-wheel being elevated (as shown in the section), so that the main shaft may pass at a height of 7 feet from the ground, immediately under the upper-floor joists, and thus give head-room for passing in and out of the barn at the back. This wheel is cogged, and drives a pinion-wheel from its upper side. The whole is boxed off by a partition, so as to be secure from accidents, as ought to be the case with all revolving shafts or cog-wheels which are at all within reach, as the smock-frocks of the men and the dresses of women, being caught by these parts of the machinery, might cause serious accidents. It is well also to have a bell-pull in the engine-house, communicating with a bell near the thrashing-machine, by which the engineer should always give notice before he lets on the steam. All the doors connected with the engine-house are made

SECTION THROUGH ENGINE-HOUSE.



[Scale ⅛ inch to a foot.]

The Fly-wheel (A) is raised so that the main shaft is carried just under the upper-floor joists.
B, Mill-stones on upper floor, worked by a bevel wheel.
C, Spur-wheel, driving a drum from which a belt is carried to the shaft, which works the Chaff-cutter and other small machines in Straw-barn.

to open *outwards,* as has been recommended by several coroner's juries, before whom repeated instances have been given of death from scalding when an explosion has occurred, in consequence of the escaping steam having closed the doors of the engine-house, thus preventing the exit of those within; whereas, had they opened *outwards,* the force of the steam would rather have driven them open. As a further security against accident, the engine-house is nearly detached from the rest of the buildings, and is divided by a thick wall from the small part with which it is in contact. It may have a fire-proof ceiling and brick or stone floor.

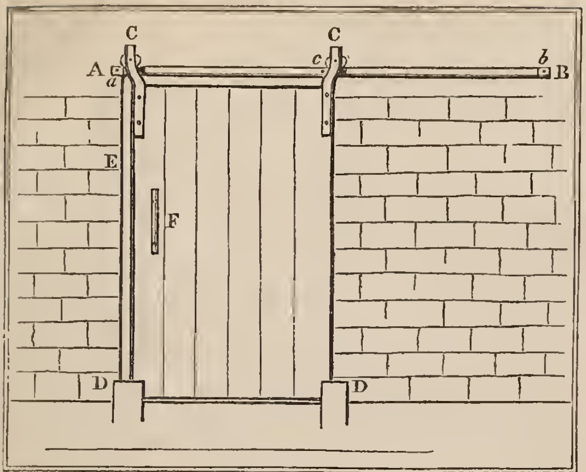
Steaming-room and Root-house (*e*).—The room for cooking the several articles of food prepared by the machinery comes next in succession. The agent employed would be chiefly the waste steam from the engine, which, instead of being blown up the flue, may be conducted by an underground pipe, and turned on or off by a cock. When the steam is not got up for the engine, it may be supplied by a boiler in the steaming-house, which also serves for boiling linseed, roots, pig-wash, &c. This being provided with a lid fitting into a water-joint, the steam from it is conveyed down through a pipe between the true and the false bottom of a wooden chest, the latter pierced with holes, by which the steam ascends through the chaff, linseed, meal, roots, &c., placed in the chest. A cock at the bottom lets off the condensed water. A root-house (*p*), with wide doors to allow a cart to be backed into

it, adjoins, where roots may be sliced for cattle or cut up for sheep.

From this central position the food, whether cooked or raw, and the cut litter is distributed on all sides; for which purpose a two-wheeled barrow or truck made of basket-work, such as is seen at railway stations, is of great service, and will run either on the ground or on a tram-way. The several classes of animals will probably be fed and attended to by different men, excepting only when the boxes require emptying, and it has been found an excellent plan that some one man, as the swineherd for instance, should be charged with feeding and littering the horses, and have the key of the feeding-passage in the stable, and of the horse-corn loft and bin. By this plan the horses are all treated alike, and are secure of a good feed before going to work of a morning, and also when they come home in the middle of the day and at night, when they find their racks and mangers ready supplied, and are able immediately to fill themselves and lie down, which would not be the case if left to the care of tired carters. A marked improvement has, in the writer's experience, followed the adoption of this plan, and there is also less liability to waste and peculation in their corn.

Horse Stable (*f*).—The horses are watered at a trough supplied by a pump, between the sheep-sheds (*o*), a few feet from the stable, and the harness of each is hung in a corner of his box, which is railed off for that purpose. The advantage of this is, that the harness for each horse is ready at once; there is no time lost in looking for a strap here and a chain there. This plan may be seen at Earl Bathurst's farm, near Cirencester. It is a practice in some parts of the country to use the stable only for feeding the horses, which are then turned into an open yard, with a shed at one side, for the night. The idea is that they are thus kept more healthy than they would be in a stable; and probably it may be so if a close, ill-ventilated, and filthy building is appropriated to them. In the loose boxes here proposed, sufficient shelter is combined with liberty of motion and fresh air, and they are safe from injury from biting or kicking each other, whilst each can stretch himself at his ease on his bed. By means of openings in the roof and air-bricks, a sweet and wholesome atmosphere is obtained. These boxes, it will be observed, are not excavated to the depth of those for cattle, as the horses are not so constantly in them; and when the more heating and ammoniacal nature of their urine is taken into account, with the absence of pressure during several hours of the day, there might be more likelihood of fermentation taking place in the manure. With this precaution they have been found highly advantageous at the farm of Charles Lawrence,

Details of Doors of Horse-Boxes.



[Scale ¼ inch to a foot.]

A B, an Iron Bar 1¼ inch × ½ inch, bent at each end so as to project from the wall ¾ of an inch, and bolted to wall-plate at *a*, *c*, *b*.

C C, Bent Iron Straps, clipping the door on each side, and fitted with wheels by which the door is suspended, and runs easily along the iron bar.

D D, two pieces of wood fixed in the ground, with a groove in each to keep the door in its place.

E, an upright piece of wood, against which the door shuts.

F, the handle by which the door is pulled backwards and forwards.

Esq., near Cirencester, where a depth of one foot for the horse-boxes has been adopted. The doors are suspended on rails, on which they run back and forwards, as in the annexed sketch. Corn, chaff, &c., may be poured into each manger from the feeding-path; and opposite to the man entering by this path is the rack for each box, into which he can pitch the hay, green food, &c., with the fork; or perhaps these might as conveniently be brought into each box by the external door, in which case the rack would be best placed in a corner near the door. This stable is principally copied from one of Mr. Lawrence's, above alluded to.

Sheep Sheds (*o*).—Beyond the stable, but at no great distance from the chaff and turnip cutting machinery, the cake store, &c., is the shed for fatting sheep, which is (on a reduced scale) a copy of those used by Sir Richard Simeon, Bart., in the Isle of Wight, and invented on his property. In the original sheds each sheep is in a separate stall; we have thought that half the dividing boards, at any rate, might be dispensed with, as the chain by which each animal is fastened will still prevent them from interfering with each other's food; and perhaps there may

be some slight advantage in having animals of the sociable nature of the sheep in pairs, although experience shows that they do exceedingly well in separate stalls. However this detail may be arranged, the grated cover to the manure tank, which runs behind all the stalls, should be made in lengths for two sheep to occupy one length, viz. 4 feet, for convenience in lifting the grating when the tank is emptied. These gratings are composed of bars of inch stuff, 2 inches wide, and laid at an interval of one inch, nailed to three crossbars or sleepers. The dung which does not fall through of itself is swept through the bars at each feeding-time, about five times a day. The tank is 2 feet wide, and excavated about two feet. Some dry ashes, gypsum, &c., may be thrown into it occasionally to absorb the urine; and when cleaned out, the valuable manure is wheeled along the central paths to a shed, provided on the plan at *m*, where by mixing it with ashes, burnt soil, or other dry material not of a caustic nature, it may be rendered fit for the drill. At Sir Richard Simeon's farms the practice is to use either 40 bushels of this dry mixture to the acre for wheat, or 26 bushels mixed with 4 bushels of bones dissolved in acid per acre for Swedes.

The sheep are supplied with water, if necessary, in a cast-iron trough between each pair, kept always full by a ball-cock communicating with the cistern and pump between the sheds. This open space of 4 feet between the parallel sheds supplies ventilation and light, by louvre or luffer boards above the racks and mangers, the vitiated air being conveyed off by ventilators in the gables at each end. Thatch will probably be the most suitable roof, from its cheapness, and being a non-conductor of heat, and the distance from the steam-engine, &c., makes its combustible nature of less consequence. The low walls may be made in many parts very reasonably of wattled furze, which is warm and comfortable, and of which the chief part of the buildings on Mr. Huxtable's farms in Dorset are constructed. At Earl Bathurst's farm near Cirencester, a shed on a similar plan to the above, only in one length, is found to answer well, built of stone and slate.

At the entrance of the premises on this side is a weigh-bridge (*g*) connected with a small office, so that everything that goes in or out may be weighed—coals, cattle, corn, &c.

Cattle Boxes, or Fatting House (*q q*).—Returning again to the central cooking-room, immediately adjoining it we enter the fatting-shed for cattle, as these animals will consume the greatest bulk of the food here prepared, which may be run down between the boxes on a tram-way, or carried in bushel-baskets. With a proper proportion of roots, no water will be needed in winter; but if necessary it may be laid on to the cast-iron troughs as before described for sheep. These boxes are excavated two feet,

and when the cattle are first put up, some dry ashes, burnt earth, sawdust, or other absorbent material may be spread at the bottom; and after a few days the bed of litter accumulated will quite absorb all the urine, and they will be kept perfectly dry and sweet if littered once a day, the litter being shaken up once a day besides. If cattle are pretty fresh in condition when first put up, they may be replaced three times in the twelvemonth, being fed in summer on tares, rye-grass, chaff, and oilcake. Sufficient light and ventilation will be secured by glass slates in the roof, at a cost of 1*s*. each, or rough plate glass, and by leaving an interval of about 3 inches between the top of each door and the wall plate, some of the slates in the roof being raised at one end to allow the escape of air. The manure is easily removed from each box by a cart backed up to the open doorway; and may be ploughed in, or drilled immediately in a moist state, so that the fermentation is at once applied to stimulate and nourish vegetation, nothing being lost by previous fermentation, or by exposure to the elements. A covered manure depôt (*s*) is provided in the yards, and others may easily be constructed on the outside of the buildings to the south, should it be wished to store up dung at any time of the year. Though on the box system of feeding each animal occupies more superficial space than when tied up in stalls, the excavation of the box enables much to be saved in height of walls above the foundation, and the large doors also are a cheap substitute for walling, and being kept dry by being under the spouted eaves are not exposed to the weather. The width also of the building is less, as it is not necessary to have room to pass behind the animals; and the expense of pitching or paving the floor of the whole building is saved. The ease and comfort which the animals enjoy, enabled to stand or lie in any position, to rub themselves, and to put their heads through the bars to lick one another, and the saving of the time, otherwise consumed, in continually cleaning out stalls, are advantages which seem to render it probable that box feeding will be more and more widely adopted, and have therefore influenced us in adapting our plans to this arrangement. By this system, also, the cost of liquid manure tanks, with the pipes and pumps necessary to that system, and the very heavy expense of pumping it into carts and applying it to the crops, are saved.

Piggery (*t*, *u*).—The boxes for fatting pigs are copied from those at Mr. Lawrence's farm, near Cirencester. Three or four, according to size, may be fed in each box. The only reason why boxes appear rather less adapted to the pig than to other animals is, that the inclination to rout up the dung with the snout makes the dung just on the surface less compact than it otherwise would be. The boxes, notwithstanding, are far sweeter and cleaner

than pigsties in general. The details will be sufficiently understood by the drawings and specifications. The door to this building may be dispensed with, or at least most part of the year it may be left open. Light may be admitted from the roof.

The breeding sties, *t*, at the further end of this house, for sows with litters, are, as proposed in the plans, to have the yards roofed over, the eaves of the roof being kept about two feet above the palings by which the yards are enclosed, so as to admit the air and sun, particularly at the end which is fully open to the south. By this means, and by sloping the yards towards the middle, keeping them well littered, or provided with dry saw-dust, ashes, &c., the rain being kept off, they are dry and clean, and the manure well made. We have experience of sties and yards on this plan, which are floored with a sort of asphalte made of sifted ashes, gas-tar, and spent lime—a composition which dries very tough and water-tight, and makes a sound flooring which pigs cannot rout up. The feeding-troughs for these yards may be conveniently filled by means of a hinged flap, as shown in the figure. The flap is suspended to the iron bar *a a*, by iron straps bent round the bar, and secured to two of the bars of the flap *b b*, so that the flap swings freely, and would naturally hang in a vertical

Fig. I. Trough-flap shut.

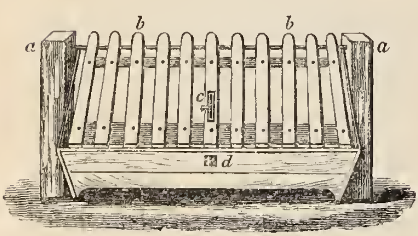
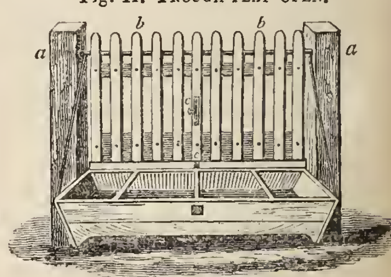


Fig. II. Trough-flap open.



[Scale $\frac{1}{4}$ inch to a foot.]

position, as in Fig. II., where it is represented with the trough exposed ready for being filled. The bolt *c*, being dropped on the other side of the trough, keeps the flap in its place, and the pigs cannot get at the food till the trough is full. As soon as it is filled, the bolt *c* being raised, the flap is pulled forwards and the bolt inserted into *d*, a hole in the front of the trough, which keeps it securely in its place, as in Fig. I., and allows the pigs free access to their food. The bolt *c* is secured to the flap by staples on the inside, and moved up and down by a button *c*, which comes through a hole in the centre bar of the flap. It is also convenient to have two or three rails somewhere in the side of the yard of the sty, united, or a board, which may be slid up

and kept suspended by a peg through it resting on a rail of the sty, so that the young pigs may be let out to run in the farm-yard, the sow being kept in the sty, like a hen with a brood of chickens in a coop.

Dairy (*w*).—The position of this building is determined with reference to the milch-cows and the pigs. It has windows only to the north, part of the lights being filled with pierced zinc for ventilation. A good supply of water is essential, and the butter-milk and whey may be run into the pig-vault from the sink. Cheese-vats, presses, churns, &c., would occupy part of the room, the rest having milk-pans or cisterns along the walls. The floor above would be a cheese-room. Adjoining is another root-store *x*, with a wide door to the exterior, allowing a cart to shoot a load of roots into it for the cows.

A fowl-house, to which the birds ascend by a slight ladder, is placed here, as the poultry would pick up their living in the stack-yard.

Farmer's Nag-stable, Gig-house, &c. (*y*).—Supposing the farm-house situated towards this side of the premises, the nag-stable, gig-house, and harness-room have been added here. It is supposed that all three are entered by one door—that in the stable; the others opening only from the inside. A hay and straw loft is made above, the haystacks being close at hand. A private door gives the farmer access from his stable-yard to the farm-stead, and we next come to the

Cow-boxes (*v*).—They are on a similar plan to those for fatting cattle in most respects, excepting that, being of only one story, the construction is slighter. As they must be entered separately to milk the cows, the pathway at the heads of the animals might perhaps be dispensed with, and they might be fed by entering each box separately, by which the span of the roof, and of course the cost of construction, would be lessened. Some, too, might prefer having a small open yard of, perhaps, 14 feet by 10, attached to each box, so that the doors on fine days might be left open for the cattle to go in or out as they pleased. In that case the excavation of the box might be somewhat reduced—towards the doorway at least.

Yards and Sheds for Young Stock, Lambing Ewes, &c. (*r*, *r*, *r*).—Beyond the buildings which have been now described, there is, on each side of the central building, a yard and shed, open in front, which will be useful for a variety of purposes. In lambing time, for instance, the ewes may be housed under them. A compartment may be partitioned off, and closed in with thatched hurdles or other means; and thus a house made for an animal attacked by illness. Calves, colts, young pigs, &c., may be turned in here. In the south-east corner, the furthest removed from the

cows, is a house for a bull, *n*. These sheds are proposed to be run up of the cheapest materials, thatched, and the back made of wattled furze. They are figured in the isometrical sketch with lean-to roofs; but the cheaper plan would be to make them ridged, and the smaller elevation of those to the south would be an advantage, as they would admit more sun in winter to the yards. The plan of building with cob-walls, which is much practised in Devonshire, as a cheap material, where the walls are of a certain height, would not answer so well for low buildings like these sheds, as the substantial stone or brick foundation on which the cob must rest would make a low piece of cob expensive, though its durability would be greater than the wattled furze here proposed.

In conclusion, we beg to express our best thanks to those gentlemen who, by their kindness in explaining the arrangements of their farm-buildings, having drawings executed for us, &c., have materially assisted us in the composition of this essay, which, together with others presented to the Royal Agricultural Society, we sincerely hope may be of use in furnishing useful suggestions both to landlords and tenants in their endeavours to meet the ever-increasing demands on the productive powers of the soil of England.

SPECIFICATION of the several Works required to be done in the erection and completion of a Farmstead according to the accompanying drawings.

Excavator.

To dig all trenches of the required dimensions, tanks and other earthwork necessary; to ram to the walls as the works proceed; level the surface of yards and unpaved floors, and remove to a convenient distance all superfluous earth or rubbish.

Bricklayer.

All the walls coloured red upon the drawings to be constructed with good, hard, and well-burnt common bricks, laid in mortar in the proportion of 3 to 1; good lime and clean, sharp sand.

The water-tanks, crown, and floor to be arched 4½ in cement, and the inner half-brick of sides in cement also; an 18-inch man-hole in centre of crown to each; the two large tanks to have ¾-inch tension, bolts, plates, nuts, &c., complete. All retaining and division walls under wood framing, rails, &c., between stalls or to sustain passages, to be 9 inches thick, the upper course to form a coping, laid edgewise in cement; sills of the same to doors and windows. All piers not more than 2 ft. 3 in. by 1 ft. 6 in. to be of brick, above ground, upon rubble stone footings 6 inches broader each way. The footings of one story walls to be 6 inches, and those of two story 9 inches broader than the superincumbent work. The flues to be lined with

bricks and plastered on a circular tube built into the stonework and

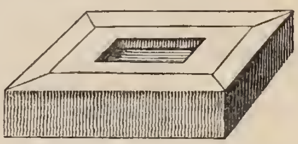
secured with cement at the joints. Arch-bars and all other requisite iron-work to be provided. All troughs, cisterns, &c., to be underbuilt as required, and relieving arches to be turned over all openings. The exterior windows and door-arches and quoins to be constructed with selected hard-burnt bricks, unless the quality of the stone is good, and not more costly.

The floor of root-store from junction with boards to be laid with hard, common bricks flat in mortar, also those of office, joiner, and smith's shop, saddle-room, and gig-house; door-sills the whole thickness of walls on edge wedged in cement. All bond or bearing timbers to rest upon bricks levelled upon the stonework: a 2-inch tube drain from sink of dairy to wash cistern.

Mason's Work—(Rubble Walling, &c.)

All the walls coloured brown upon the plans to be constructed with local stone, of approved quality in 'random' courses, with mortar composed of fresh-burnt stone, lime, and gravel, in the proportion of 4 to 1. Through stones in every 2 feet 6 inches superficial, the whole well tailed and bonded together, and the courses flushed up with grout and gravel. All footings up to the ground level of one-story walls to be 22 inches thick, two-story 26 inches, laid upon large flat stones; those to engine-flue and piers to be solidly built and grouted 6 inches larger each way, and the brickwork commenced upon large flat stones. The walls enclosing machinery, which are 2 inches thicker than others, to have an extra number of through stones, and to be of a superior quality of random work.

All wood story-posts, or supports to roof timbers, to rest upon a stone slab not less than 6 inches thick, fixed firm and level upon the footings, roughly axed and levelled, and sunk to receive foot of post: the double ones of cow-boxes to be in one length. Hook-stones with strong hooks sunk and leaded in, to be fixed to all the doors opening externally, except those hung to posts.



A 2½-inch coping to be placed upon the brick piers of lean-to sheds, roughly axed, and projecting 1 inch all round.

The dairy floor to be laid with 2-inch York tooled flags, laid in mortar, and a 6-inch tooled and bevelled sink stone provided and fixed. Covers of stone to each man-hole, with iron rings securely fixed and headed.

All external walls to have neat tuck-pointing with coloured mortar, internally laid flat and white.

Carpenter and Joiner,

Construct roofs and supports as follows:—

Cattle Boxes (see Section).

No. 10 pair of Principals, with—

Of Memel Fir	Tie Beams, or Collars	5 × 4	Brestsummers, or Plates	6 × 4
	Principal Rafters	6 × 4	Eaves' Spar	3 × 2
	Purlins	7 × 4	Ridge	7 × 1¼
	Struts	3 × 3		
	Wrought Iron Straps and Bolts.			
Of Larch	Common Rafters	3½ × 2		
Of Axed Elm	Story Posts	6 × 6		

The divisions in these boxes to be formed with split rails of larch or ash fixed into the story-posts, three in height as shown; the two upper rails

to be capable of being fixed at different heights by means of a stud at one end to enter holes in a post, the other end being secured by an iron pin passing through the end of the rail, and through two fillets nailed on the outer story-post; an intermediate axed elm post, and one rail in height, to divide off the passage, also morticed into the story-posts; the short post to have a joggled, rough foot built into retaining wall.

Cow Boxes.

No. 5 pair of Principals—

Of Memel Fir	Tie Beams	5 × 4	Ridge	7 × 1
	Principal Rafters	6 × 4	Eaves' Spar	$3\frac{1}{2}$ × 2
	Purlins	$6\frac{1}{2}$ × $3\frac{1}{2}$	Brestsummers	6 × 4
	Struts	3 × 3	Plates and Pads	5 × 3
Of Larch	Common Rafters			$3\frac{1}{2}$ × 2
Of Elm	Story Posts			6 × 6

The divisions in these boxes to be formed as before with split rails and rough elm posts between story posts.

Barn and Dairy (see Sections).

No. 8 pair of Principals—

Of Memel Fir	Tie Beams	7 × 4	Ridge	7 × $1\frac{1}{4}$
	Principal Rafters	4 × 4	Purlins	7 × 4
	King Post	4 × 4	Plates and Pads	5 × 3
	Struts	3 × 3		
Of Larch	Common Rafters			$3\frac{1}{2}$ × 2

Engine House, Hay Loft, Carpenter and Smiths' Shop.

No. 4 pair of Principals—

Of Memel Fir	Tie Beams	6 × 4	Purlins	6 × 4
	Principal Rafters	4 × 4	Plates	5 × 3
	King Post	4 × 4	Ridge	7 × $1\frac{1}{4}$
	Struts	3 × 3		
Of Larch	Common Rafters			$3\frac{1}{2}$ × 2

Horse Boxes (see Section).

No. 3 pair of Principals—

Of Memel Fir	Tie Beams	8 × 4	Struts	3 × 3
	Principal Rafters	4 × 4	Plates	5 × 3
	Purlins	7 × 4	Ridge	7 × $1\frac{1}{4}$
Of Larch	Common Rafters			$3\frac{1}{2}$ × 2
Of Elm	Story Posts			6 × 6

The divisions in these boxes to be formed with split horizontal rails, with vertical braces nailed against them as shown, built into the wall at one end and fixed into story-posts at the other.

One height of strained iron wire, to form divisions from passage, stiffened by an intermediate post sunk into the ground and tarred, 5 × 5.

Pig Boxes (see Section).

Memel	Brestsummer	6 × 4	Ridge	7 × $1\frac{1}{4}$
	Plates	5 × 3		
Larch	Common Rafters and Diagonal Braces			4 × 3
Elm	Story Posts			6 × 8

The divisions to be formed with rough posts, split rails, and slabs, as shown, each to have a wicket, ledged and braced, hung with hooks and bands and a fastening. The yards to be enclosed and divided in a similar

manner, and each to have a swing feeding-door, barred, ledged, and braced, hung to a round iron rod, having a long vertical bolt with handle fixed in the centre; these doors to swing inwards or outwards, the bolt to shoot into a hole in the front of the trough: a 1-inch 1 foot 6-inch wide door, swinging both ways, in the yard division next the covered sties.

Implement Sheds (see Section).

Bull and Manure House.

Memel	Brestsummers	8 × 6	Plates	0 × 0
	Ridge	0 × 0		
Elm	Story Posts			8 × 8

These roofs to be formed with fir pole rafters and collars, and the plates tied together over each story-post and pier with a $1\frac{1}{4}$-inch iron tension rod, nuts, plates, &c.; each side of manure-shed to be closed with 3 moveable split rails in height dropped into staples.

Sheep Ties (see Section).

Memel	Brestsummers	6 × 4	Ridge	0 × 0
Elm	Story Posts			6 × 6

This roof to be formed with fir poles and collars as above, spiked or strapped together.

The spaces between piers to be closed with split rails or poles built in and stiffened with stakes, the whole then interwoven with faggot or furze. The spaces between story-posts to be filled with $\frac{3}{4}$ luffer boarding, from the height of mangers upwards, with vertical shifting laths, pins, &c., complete.

Divisions between ties to be $\frac{1}{2}$-inch braced boarding.

Lean-to Sheds (see Section).

No. 12 half-pair of Principals—

Of Memel Fir	Principal Rafters	4 × 4	King Posts	4 × 4
	Tie Pieces	5 × 4	Struts	0 × 0
	Brestsummers	7 × 5	Ridge	0 × 0
Elm	Story Posts			6 × 6

These roofs to be formed with split or round poles to receive thatch.

The spaces between piers to be closed with rails built in, stiffened with vertical stakes and wound as before with furze or faggot.

The whole of the foregoing Memel timbers to be from the saw, and that of larch also; the elm posts dressed with the axe only, but the whole firmly framed together with all necessary straps, bolts, or other ironwork. All timbers not straight or partially round to exceed the dimensions figured; no rafters to exceed one foot apart; all the slated roofs to be battened with $2\frac{1}{2} \times \frac{3}{4}$-inch battens, and to have diagonal or 1-inch × 5-inch tilting fillet at the eaves. All valleys to have $\frac{3}{4}$ boarding on proper bearers; inch poplar stairs with $1\frac{1}{2}$ strings, handrail, and balusters, to be fixed when shown complete; wood bricks when required, and strong lintels over all openings.

Floors.

The floors of barn, granary, and drying-room (for the present), and also cheese-room, hay-loft, and passage from granary to be formed of Memel fir timber of the following scantlings:—

Barn and Cheese-room.

Of Poplar . .	Girders	14 × 9	Ground Floor Joists	5 × 3
	Joists	8 × 3		

Boarded to the extremity of Corn-bin with 1 in. rough boards.

Granary.

Of Poplar . . Joists, double bridged 8 × 3 Joists, passage . . 6 × 2

Boarded with smoothed 1 in. boards.

Nag Stable.

Of Poplar . . Joists, single bridged . . . . 6 × 2

Boarded with ¾ in. rough boarding.

Traps to be formed and hinged over ladder and fodder-rack. The pigeon-house and fowl-roost to be formed with rails and rough boarding close jointed; the floor of straw-barn to be covered with wattled hurdles: the whole of the foregoing roof or floor timbers resting upon walls to lie upon 4 × 3 Memel bond and pads, laid on bricks in mortar, and all the wall-plates to be connected through gables with the same, or 1-inch × ¼-inch iron straps, clipping the ends of plates.

Poplar Doors and Boarding, &c.

The doors of cattle and cow-boxes to be formed with split rails and ¾-inch rough boarding, 3 inches shorter from the top than opening, and 6 feet wide; these doors to be diagonally braced and hung with 24-inch hooks and bands to the story post, each to have an iron hook fastening lifting into a staple, and shutting against the second story post.

Double doors to be 1-inch rough boarded, 1¼ ledged and braced, hung to hook stones with 16-inch bands, falling against an elm stop sunk 3 feet into the ground and provided with a staple to receive link at bottom of door; each pair to have a long wrought-iron bolt to shoot into lintel, and an external swing bar fastening, staples, &c., complete. The remaining doors upon ground-plan to be inch ledged, square-jointed; those opening externally hung to revealed hook-stones with 12-inch hooks and bands; those opening inwards to be hung in 5 × 3 Memel frames, built in and resting upon plinth stones with dowels in foot; those of upper floor the same, except straw doors, which may be ¾ ledged, latch and catch to each.

Horse box doors to be 1-inch ledged and braced, and suspended upon 1¼ × ½-inch iron rail, with bent straps clipping the top of door and fitted with wheels, the door to open and shut against the pins of suspension rail, and a wood stop built in wall half the height of doors, which slide behind two elm stops forming a groove at the foot; a 3 × ¾-inch casing to be run round the openings and scribed to the doors; each door to have an exterior handle and fastening inside; all boarding between story posts, exterior passage from granary, &c., to be against split rails and ¾-inch rough.

Fittings.

Quarter circle cast-iron manger 2 feet radius to be fixed in all the cattle and cow-boxes, and also pig-boxes in 1·9 radius; a semicircular water-trough of the same radius to be fixed in each pair of cow and cattle-boxes.

The sheep ties to have cast-iron troughs, one to each pair of ties for water, 1 foot × 6 in. × 6 in., and one manger to each tie of the same description and size.

A green fodder-rack formed with top and bottom rails and vertical staves 1 foot deep, to be fixed above the mangers the whole length of the ties;

cast-iron mangers (½ circles) and wrought-iron fodder-racks to be fixed in nag stable and horse boxes, secured by flanges to story posts; a poplar water-trough to be fixed near sheep ties of the size shown and 1 foot deep, supported upon low piers for horses to drink from.

A 2 foot by 2 foot 4 × 3 frame and 1-inch ledged shutter to be fixed above man-hole of wash cistern.

Gates.

Common field gates to be fixed to 1-foot square posts where shown, and connected with walls by split rails built into the work at one end and let into post at the other; the double gates to be sawn and framed, and to fall against elm stops fixed in the ground, all hung with hooks and bands and to have suitable fastenings.

Post and rail fence to be fixed round manure tank, the rails in centre compartment of each side to be moveable.

Slater.

All the roofs except those of sheep ties, implement sheds, manure, bull-house, and lean-to's to be covered with Countess slates secured with metal nails not less than 2 in each slate; 2 slates over each box to be lifted 1 inch for ventilation, or laid 1½ inches apart over a surface of 4 feet superficial. One glass slate to be fixed over each box: this applies to horse, cow, and pig-boxes. The ridges and hips to be covered with sawn slate cresting, secured with plugs: pointing to gables, chimneys, &c., to be done in cement.

Thatcher.

The roofs of sheep-ties, implement sheds, manure, bull-house, and lean-to's to be thatched upon hazel-rods, with all the necessary pegs, tar cord, &c., the eaves and ridges to be securely tied down.

Plumber, Painter, and Glazier.

A 2½-inch common lead pump to be fixed complete in the dairy, and communicating with rain water tank.

The water to be laid on from the slate cisterns provided in all the sheep-ties; cattle and cow-boxes with ¾-inch cast-iron piping, regulated in the cisterns by ¾-inch ball-cocks.

All the valleys to be laid with 5lb. milled lead, and all necessary flushing to be done of the same material.

All *external* woodwork from the saw to receive a coat of coal tar; the remainder, three coats good oil colour (this is not included in the estimate).

All the windows shown upon the plans to be of cast-iron square lights, 4 feet × 3 feet, glazed with crown glass, with stays, fastenings, &c., complete. The lower halves of dairy windows to be filled with perforated zinc; a glass slate to be fixed over each cow, horse, and pig-box; a ¾-inch lead pipe from sink to drain.

The whole of the herein described works to be completed in a workmanlike manner, according to the plans and this Specification, the contractor supplying all tools, workmanship, and materials of whatever description necessary to carrying on the same, local cartage excepted, and to complete the whole to the satisfaction of the surveyor or architect.

Estimate for the Erection of Farmstead according to the annexed Plans and Specification.

No.	Measurement.		s.	d.	£.	s.	d.	£.	s.	d.
		Stone Work.								
577	perch	Superficial 18-inch random rubble work	4	3	134	12	8			
259	,,	,, 20-inch thrashing-barn work	4	9	71	12	7			
11	pair	,, hook-stones and leading	2	0	1	2	0			
8	,,	,, plinth-stones	1	6	0	12	0			
78	single	,, base-stones to story-posts	1	9	6	16	4			
	Yds. ft. in.									
	0 23 4	,, 2½-inch coping	0	10	0	19	6			
	0 15 0	,, 6-inch double sunk sink	1	3	0	18	9			
	0 6 0	,, 3-inch door-sill	0	10	0	5	0			
	0 440 0	,, 2½-inch York flag floor	0	6½	11	18	4			
								228	17	2
		Brickwork.								
270	perch	Superficial 1-brick thick brickwork	7	10	105	15	0			
	Yds. ft. in.									
	45 0 0	,, brick on edge, in cement	3	0	6	15	0			
	183 0 0	,, brick flat floors	2	0	18	6	0			
	29 0 0	,, ½-brick in cement	3	2	4	0	10			
	33 0 0	,, ½-brick vaulting, in cement	5	3	8	13	3			
	1½ 0 0	,, brick flat in cement	2	8	0	4	0			
	0 102 0	Lineal arches to doors and windows	0	10½	4	9	3			
	0 15 0	,, 2-inch clay tube drain	0	3	0	3	9			
								148	7	1
		Carpentry.								
	Squ. ft. in.									
	116½ 0 0	Superficial labour and nails to roofs	4	0	23	6	0			
	116½ 0 0	,, 2½ × ½ battening for slates	7	6	43	13	9			
	24 0 0	,, labour and nails to floors	4	0	4	16	0			
	2½ 0 0	,, double bridged ditto	7	0	0	17	6			
6	..	,, beams extra	5	0	1	10	0			
	Ft. in.									
	1026 0	Cube Memel fir timber	2	0	102	12	0			
	196 0	,, elm timber and labour	1	3	12	5	0			
33	..	,, principals, labour to	3	0	4	19	0			
	40 0	Lineal labour to vallies	0	2	0	6	8			
	60 0	Superficial ¾-inch gutter boarding	0	6	1	10	0			
	500 0	Cube larch rafters	1	0	25	0	0			
	30 0	,, undressed door frames	2	4	3	10	7			
	3 0	,, dressed and rebated frames	2	6	0	7	6			
	924 0	Superficial 1-inch poplar doors, ledged, braced, rough from the saw, and square jointed	0	5	19	13	6			
	94 0	Superficial 1-inch poplar doors, smoothed and rebated	0	7	2	14	10			
	807 0	Superficial 1-inch poplar doors, rough from the saw and railed, with diagonals	0	5	16	16	3			
	1986 0	Superficial 1-inch poplar floors	0	4	33	2	0			
	422 0	,, 1-inch poplar floors, smoothed	0	5	8	15	10			
	60 0	,, 1-inch rough poplar floors, outside boarding	0	4	1	0	0			
	30 0	Superficial ½-inch casing	0	2¼	0	5	7¾			
	260 0	,, ½ inch braced sheep tie divisions	0	3½	3	15	10			
	348 0	,, 1-inch cross-bar gratings	0	4	5	16	0			
	174 0	,, fodder rack	0	3	2	3	2			
	1715 0	Lineal split larch rails	0	1	7	2	11			
	15 0	Superficial 1¼ water trough	0	3	0	3	9			

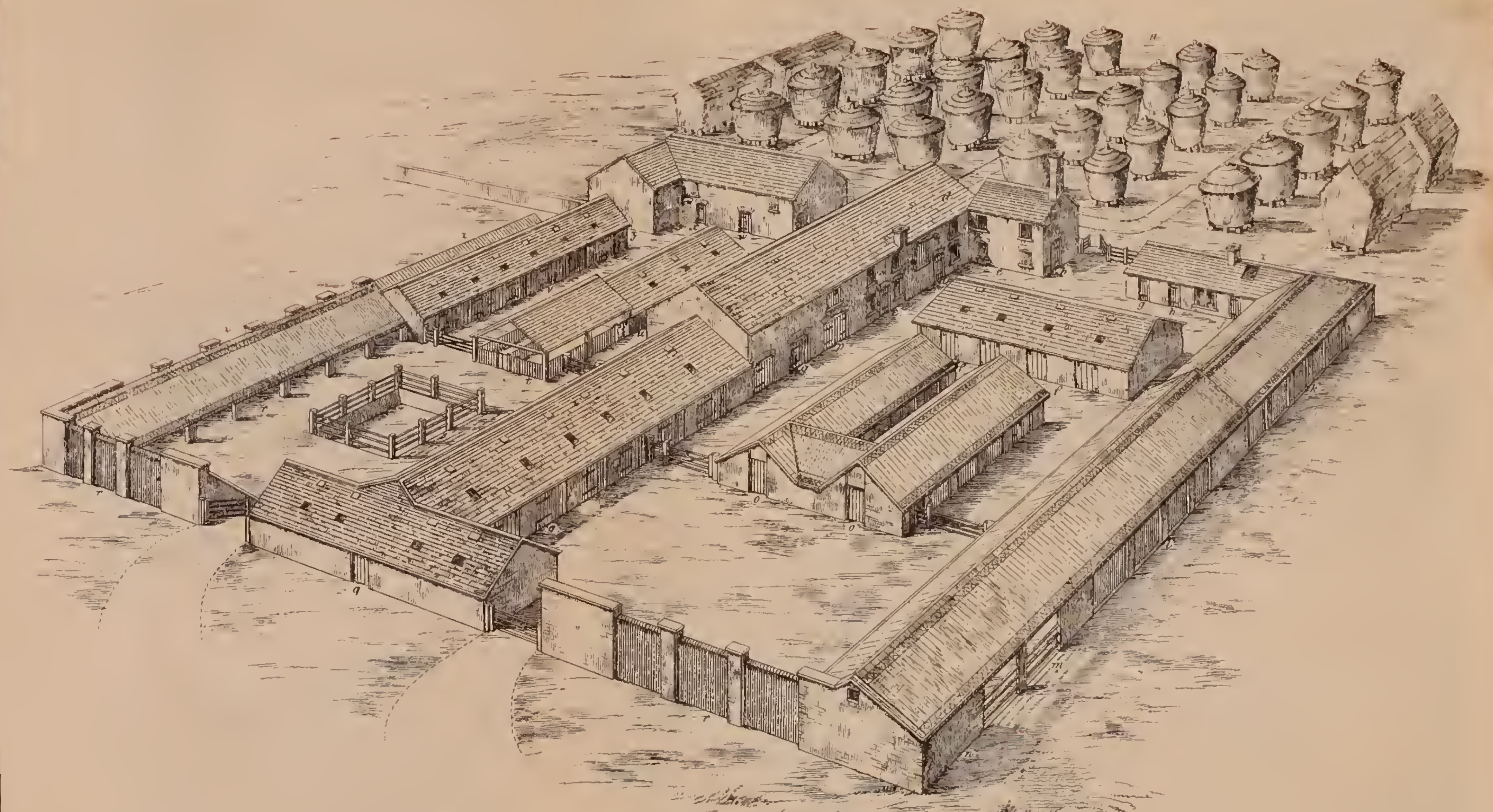
Estimate for the Erection of Farmstead, &c.—*continued.*

No.	Measurement.	CARPENTRY—*continued.*	s.	d.	£.	s.	d.	£.	s.	d.
	Squ. ft. in.									
	2 0 0	Superficial pole and slab floor to fowl roost and pigeon-house	20	0	2	0	0			
	0 777 0	Superficial hurdles, wattled, and pole-joist to straw-barn floor	0	6	19	8	1			
	206 0 0	Superficial poles, and wattling-walls. .	0	6	5	3	2			
	0 434 0	,, split rails and slabs to pig-box divisions and yards	0	4	7	4	2			
	0 86 0	Lineal strained ⅜ iron wire . . .	0	0½	0	3	7			
	0 68 0	,, 1¼ × ½ suspension rails . per lb.	0	2½	1	10	0			
	0 198 0	,, 1-inch tension rods . per lb.	0	2½	5	13	4			
	61 0 0	Superficial thatch, pole, rafters, and labour	25	3	77	0	3			
39	..	,, 1-inch poplar treads and risers, hand-rails, balusters, and strings . .	2	0	3	18	0			
28	..	,, elm door stops	0	6	0	14	0			
4	..	,, swivel bars and staples comp. .	1	6	0	6	0			
16	..	,, suspension bands and wheels .	2	9	2	4	0			
8	..	,, handles	0	3	0	2	0			
12	..	,, square staples . . .	0	6	0	6	0			
24	..	,, hooks and staples . . .	0	10	1	0	0			
2	..	,, bolts, staples, and handles to pig doors	2	6	0	5	0			
4	..	Superficial 18-inch wrought bolts to double doors	0	10	0	3	4			
27	pair	Superficial 12-inch hooks and bands .	1	6	2	0	6			
24	..	,, 24-inch hooks and bands. .	2	0	2	8	0			
6	..	,, small hinges. . . .	0	9	0	4	6			
6	..	,, hooks and bands . . .	1	0	0	6	0			
9	..	,, links and staples . . .	0	6	0	4	6			
19	..	,, latches and catches . .	1	0	0	19	0			
2	..	,, 8-inch stock-locks . . .	2	0	0	4	0			
	Yds. ft. in.									
	0 21 0	Lineal vertical ladders	0	2	0	3	6			
	0 105 0	Superficial ¾-inch luffer boarding to sheep tie	0	4	1	15	0			
								461	9	7¾
		SUNDRIES.								
	0 54 0	Superficial cast-iron windows and glass .	2	4	6	6	0			
40	..	Glass tiles	1	0	2	0	0			
13	..	Semi-cast iron water troughs . . .	16	0	10	8	0			
26	..	¼-circle mangers	9	0	11	14	0			
10	..	¼-circle mangers, horses	12	0	6	0	0			
8	..	¼-circle mangers, pigs	8	0	3	4	0			
2	..	Long pig-troughs, feeding-pigs . .	10	0	1	0	0			
120	..	Sheep-troughs and mangers . . .	1	6	9	0	0			
	0 381 0	¾-inch iron piping to water-troughs . .	0	6	9	10	0			
2	..	¾-inch ball-cocks	7	6	0	15	0			
1	..	2½-inch lead pump	30	0	1	10	0			
	0 2 0	Lineal ¾-inch pipe to sink . . .	0	6	0	1	0			
	0 70 0	5 lb. valleys . . . . per lb.	0	2½	3	13	2			
								65	1	2
		EARTH WORK.								
	474 0 0	Cube digging	0	4		..		7	18	0
	Squ. ft. in.	SLATER WORK.								
	118 0 0	Superficial countess slating and metal nails.	20	0	118	0	0			
	0 469 0	Lineal slate ridges	0	5	9	15	5			
	0 142 0	Superficial 1½-inch slate cisterns and rods .	1	0	7	2	0			
								131	17	5

Estimate for the Erection of Farmstead, &c.—*continued.*

No.	Measurement.	Gates.	s. d.	£. s. d.	£. s. d.
6	..	Common field gates and posts, hanging, &c.	25 0	7 10 0	
3	pair	Of double-gates, 1 single-gate, posts, and hanging	..	6 15 0	
					14 5 0
		Total Cost of Buildings . .			1060 15 5¾
		RAIN-WATER TROUGHING.			
	Feet.	*Dairy.*			
	66	Linear 4-inch gutter	0 4	1 2 0	
	30	,, stack-pipe	0 6	0 15 0	
	25	,, 3-inch tube drain . . .	0 4	0 8 4	
2	..	,, heads	..	0 6 0	
					2 11 4
		Barn and Engine House.			
	203	Linear 4-inch gutter	0 4	3 7 2	
	90	,, stack-pipes.	..	2 5 0	
	96	,, 3-inch drain-pipes . . .	..	1 12 0	
6	..	,, heads	..	0 18 0	
					8 2 2
		Horse Boxes.			
	90	Linear 4-inch gutter	..	1 10 0	
	15	,, 3-inch stack-pipes	..	0 7 6	
	49	,, 3-inch drain-pipes	..	0 16 4	
2	..	,, heads	..	0 6 0	
					2 19 10
		Cattle Boxes.			
	149	Linear 4-inch gutters	..	2 9 2	
	24	,, stack-pipes.	..	0 12 0	
	70	,, 3-inch drain-pipes . . .	..	1 3 6	
	90	,, brick drain	..	2 5 0	
					6 9 8
		Cow Shed.			
	60	Linear 4-inch gutter	..	1 0 0	
	6	,, stack-pipe	..	0 3 0	
	33	,, tube drain	0 4	0 11 0	
					1 14 0
		Total . . .			1082 12 5¾
		The above Total includes a farmer's nag-stable, harness-room, coach-house, and lofts above. These not being a part of the farm-buildings, deduct the cost .	..	46 16 9	
		If the feeding-path at the head of the cows is dispensed with, it saves	..	7 15 6	
		If the cow-sheds are made with ridged roofs instead of lean-to, it saves . . .	..	8 18 6	
					63 10 9
		Total of Estimate for farm-buildings, according to specification, with deductions here above-mentioned, exclusive of builder's profit, and not including machinery of any kind, as shown upon the plans .	..	..	1019 1 8¾

N.B.—The elm, poplar, and rough timber, for furze wattling, &c., is supposed to be cut on the estate at a low cost.



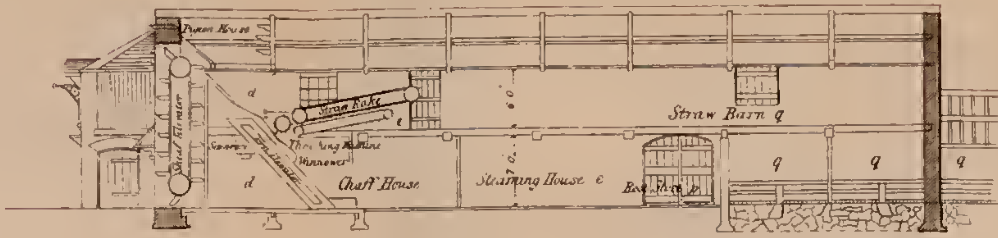
The buildings occupy about ½ an acre & 20 poles, or 2½ roods

ISOMETRICAL VIEW. x

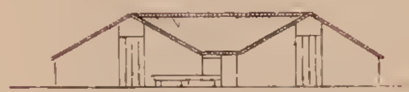
a Stack Yard & Tram ways
b Coal House & Boiler below;– Drying floor for Grain above
c Engine House below, – Granary above
d Winnowing & dressing mach.s below; Thrashing Mill stones Pigeon H.se above
e Steaming House for Cattle food below; Chaff cutter, Corn crusher, Horse corn Loft &c above
f Cart horse stable
g Office, – Weighing machine &c
h Blacksmith's Shop
J Carpenter's Shop, lighted by Skylights on both sides
k Shed for Ploughs, Harrows, Drills, Horse-rake & smaller Implements
l Shed for Carts, Clod crusher, Horse hoe, Cultivator & larger Implements
m Shed for mixing Dissolved bones, Sheep manure, Guano &c with Ashes
n Bull House
o Sheep Sheds, Horse trough, Pump &c at further end
p Root store and Cutters
qq &c Cattle boxes
rr &c Open Sheds for Young Stock. The roofs may be ridged
s Manure depot – should be roofed.
t Breeding Sties with covered yards.
u Pig boxes
v Cow House, boxes
w Dairy below – Cheese room above.
x Root Store below; – Fowl roost on other side above
y Nag stable; Harness room & Gig house below, Hay & Straw lofts above
z z &c Heaps of Mangel wurzel, Carrots, Swedes, Cabbages &c
Isometrical view Point of sight (x)

Standidge & Co. Litho. Old Jewry

Sir T. Tancred, Bart.

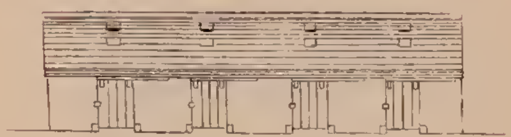


SECTION &c &c.



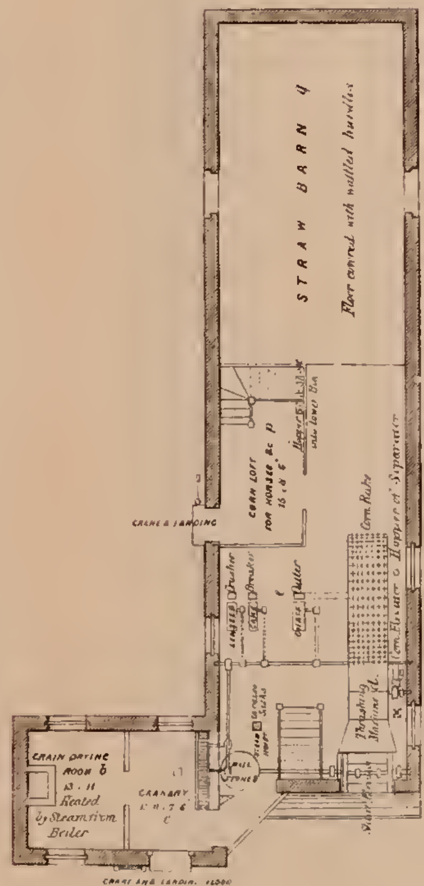
ELEVATION OF SHEEP BOXES.
o

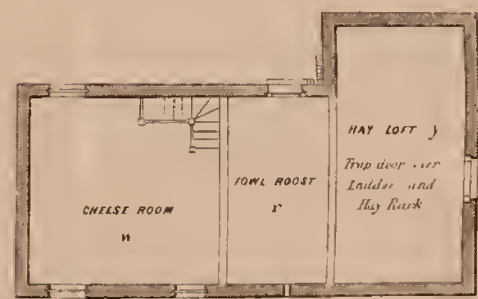
ELEVATION OF COW BOXES
v



ELEVATION OF HORSE BOXES
f

ELEVATION OF PIG BOXES
u

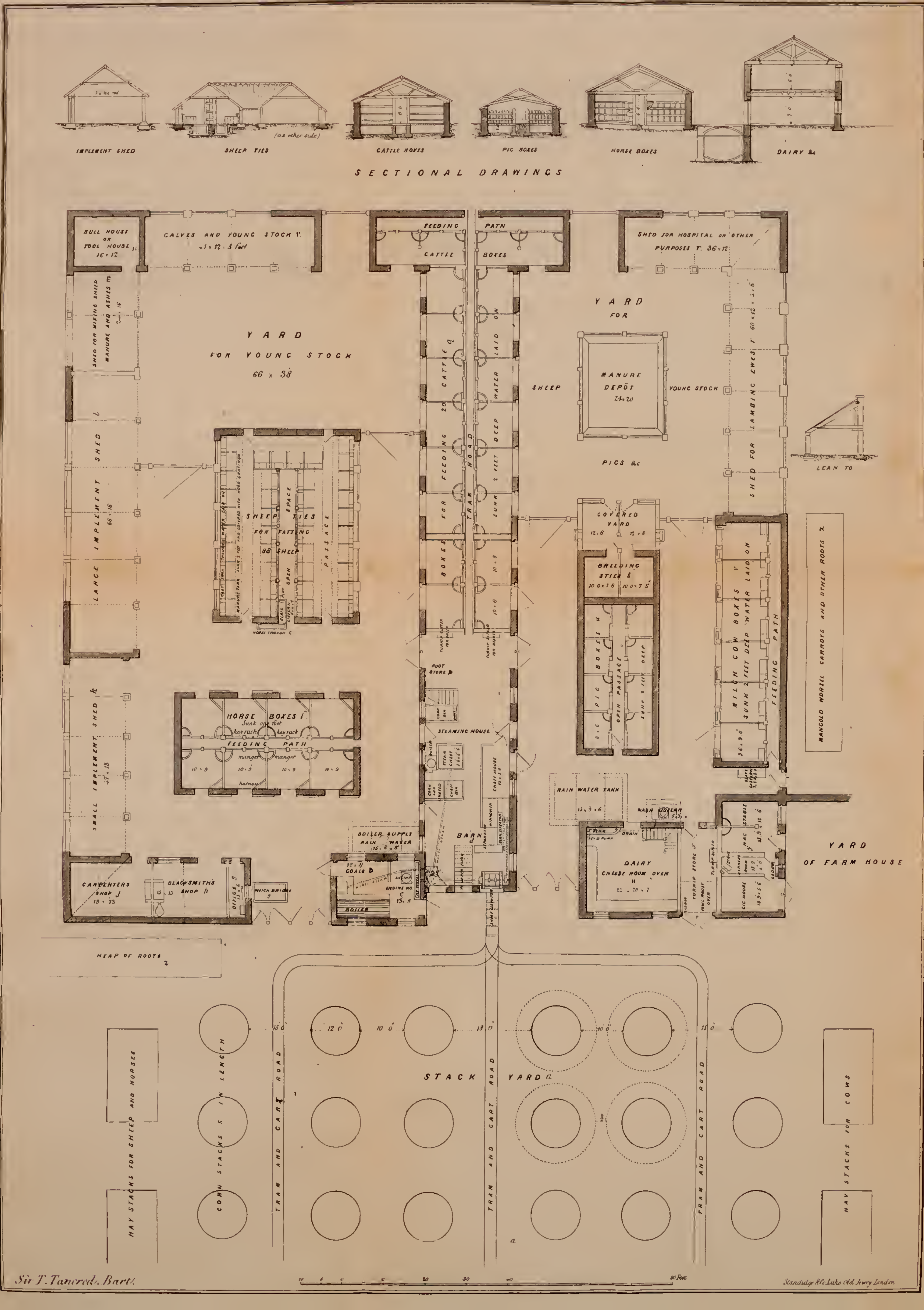




UPPER FLOOR PLANS

Sir T. Tancred, Bart.

Standidge & Co. Old Jewry London


IMPLEMENT SHED
SHEEP TIES
CATTLE BOXES
PIG BOXES
HORSE BOXES
DAIRY &c
SECTIONAL DRAWINGS
BULL HOUSE OR TOOL HOUSE 16 x 12
CALVES AND YOUNG STOCK
FEEDING PATH
CATTLE BOXES
SHED FOR HOSPITAL OR OTHER PURPOSES 36 x 12
SHED FOR MIXING SHEEP MANURE AND ASHES
YARD FOR YOUNG STOCK 66 x 38
YARD FOR
MANURE DEPÔT 24 x 20
SHEEP
YOUNG STOCK
PIGS &c
SHED FOR LAMBING EWES
LEAN TO
LARGE IMPLEMENT SHED 66 x 16
SHEEP TIES FOR FATTING 88 SHEEP
PASSACE
FEEDING BOXES FOR 20 CATTLE
TRAM ROAD
SUNK 2 FEET DEEP WATER LAID ON
COVERED YARD
BREEDING STIES
PIG BOXES
OPEN PASSAGE
MILCH COW BOXES SUNK 2 FEET DEEP WATER LAID ON
FEEDING PATH
MANGOLD WORZEL CARROTS AND OTHER ROOTS
ROOT STORE
SMALL IMPLEMENT SHED
HORSE BOXES Sunk one foot
hay rack
FEEDING PATH
manger
harness
STEAMING HOUSE
STEAM CHEST
CHAFF HOUSE
RAIN WATER TANK
WASH CISTERN
BOILER SUPPLY RAIN WATER
BARN
DAIRY CHEESE ROOM OVER
TURNIP STORE
STABLE
GIG HOUSE
YARD OF FARM HOUSE
CARPENTERS SHOP
BLACKSMITHS SHOP
OFFICE
WEIGH BRIDGE
COALS
ENGINE HO.
BOILER
HEAP OF ROOTS
STACK YARD
TRAM AND CART ROAD
HAY STACKS FOR SHEEP AND HORSES
CORN STACKS
HAY STACKS FOR COWS
Sir T. Tancred, Bart.
Standidge & Co. Litho. Old Jewry London

XV.—*On the Construction of Farm-Buildings.* By John Ewart.

Preliminary Observations.—Few subjects can better merit the encouragement, or more truly fulfil the leading object, of the Royal Agricultural Society of England than that of the present essay; for scarcely any circumstance dependent on human volition has a more direct and important tendency to the increase of the productive power of the soil than sufficiency of accommodation and proper arrangement of farm-buildings.

By the sufficiency and proper construction of his barn, the husbandman is enabled to prepare his grain-crop for market in the best order; by due shelter of the stables, to preserve the health and strength of his labouring beasts; from the warmth of lairs and folds, to obtain the largest returns in flesh at the least consumption of provender in the winter fattening of stock; and last, though not of least importance in the list of advantages to be derived from sufficient farm offices, is raising a plentiful supply of the best, the cheapest, and most generally applicable of all manures—*farm-yard muck*—to recruit fertility exhausted in the production of grain, or to meliorate natural poverty of soil. And by the proper arrangement of the buildings, as to the relative dependence of their uses, one to another, the farmer may be enabled to obtain the above-mentioned advantages at the least expense of time and labour.

If, in order to incite the proprietors of landed estates to an attention to their private interests only, apart from the importance of the improvement of agriculture to the community at large, it were necessary to illustrate the extent of advantage to be derived from a judicious application of capital to the erection of farm-buildings, numerous instances might be adduced of farms without adequate accommodation in buildings having been losing concerns to the occupiers, but on the deficiency of buildings being supplied, having proved profitable undertakings at an advance of rent equal to $7\frac{1}{2}$ per cent., or indeed 10 per cent., and sometimes even more than the latter-named rate, on the cost of new buildings. The advantage of adequate offices to the beneficial cultivation of land must, however, be too palpable, to every one having occasion to bestow any reflection on the subject, to require any argument to demonstrate the truth of such a proposition.

Notwithstanding the importance of sufficient and well-arranged buildings to successful cultivation of the soil, how frequently, in all parts of the United Kingdom, are homesteads to be met with of badly contrived construction, and the various offices arranged in relative positions ill suited to their intended purposes—without any appearance of design—dropped, as it were, by mere

chance into the places they occupy? Much as frequency of absolute defect in the matter spoken of may excite wonder, it is still more remarkable how very seldom a farmery is to be seen in any degree deserving of the epithet of *complete.*

The observations just made will apply in some, though perhaps not in an equal, degree to modern erections as well as to buildings of a date anterior to the existence of the improved practice of agriculture which now prevails. The almost constant blundering alluded to seems to arise from one or other of two causes, and frequently from a combination of both:—either from want of an exact knowledge of the uses of the different buildings of a farmery by the designer, or from want of a sufficiently comprehensive plan of arrangement with a view to extension that may be required at some period future to the time at which the design was originally made. The latter-mentioned, being a frequent cause of defect in farm-buildings, and leading to very considerable inconvenience, will be further treated of hereinafter when the arrangement of farm-buildings comes under consideration.

Having in the foregoing observations taken a general view of the importance of sufficient and properly arranged buildings in the successful cultivation of the soil, the various circumstances requiring strict attention, and most careful consideration in designing agricultural offices with a view to completeness for their purposes, will next be severally treated of previously to submitting plans, elevations, and estimates, according to the requirements of the thesis proposed for competition.

Of the Choice of Situation.—The site of a farmery should be, as nearly as circumstances will admit, in the centre of the ground with which it is intended to be occupied; it should moreover be tolerably level throughout the extent of the principal buildings, easy of access, dry, elevated above and removed from the immediate vicinity of marshes, lakes, and sluggish rivers, sheltered from prevailing winds by higher ground, and have a plentiful and never-failing supply of wholesome water. A combination of these advantages constitutes perfection of situation; it however very seldom happens that a site can be found possessing the whole of the *desiderata* mentioned; then that having the most is to be preferred, bearing in mind, however, that good access and healthiness ought never to be sacrificed for obtaining the other advantages, which, in most cases, may be supplied at a little expense. The site, for instance, if not thoroughly dry may be made so by undraining, water may be conveyed, and shelter may be provided by judicious arrangement of the buildings without much additional outlay.

Besides shelter, another important advantage may be obtained by a farmery not being built on the highest point on the farm.

The drainage water of higher ground, being collected at a proper elevation in an underground reservoir, will rise by its own pressure to a height sufficient for filling boilers, or for any other purpose so essential a necessary may be required in any part of the farmery, and a supply be thus obtained at all times without being raised by pumping or any other means by which expense may be incurred.

Of Extent of Accommodation.—The advice contained in the quotation, adopted as the motto by which to identify, in case of need, the author of this Essay, is precisely the maxim to be observed in regulating the extent of farm-buildings. In order to attain that nice adjustment of a means to an end, that a farmery may be in every way sufficient in accommodation without being so extensive as to be unnecessarily costly in erection, or expensive to uphold, the size, the purposes to which a farm is applied, and the quality of the soil, are all matters for careful consideration; for without attention to these circumstances we would be unable to '*build so, that the farmery may not require a farm, nor the farm need a farmery.*'

Arable farms whereon the winter feeding of cattle is practised require the greatest extent of accommodation. In such the necessary extent of barn and granary will be much alike; whilst the stables and implement-sheds required will be in proportion to the size of the farm; but the extent of cattle-lairs necessary will not only be regulated by the quantity of land, but will vary also according to the power of the soil to produce vegetables for the winter feeding of the beasts.

In estimating the extent of buildings a farm of any given size will require, the following process in the consideration of the subject will aid in attaining the object in view, viz., fifteen acres may be considered a fair quantity of land to be prepared and sown with turnips, according to the best mode of culture on soil adapted to the growth of that vegetable, in a season by a pair of good horses, and that quantity to be the full extent of bare fallow that can be properly worked in season by the same force. Supposing the five-shift course of husbandry as practised in the northern part of Northumberland and border district of Scotland —a locality where the most approved method of turnip culture took its rise, and is at the present time practised in the greatest perfection, and where the winter fattening of stock is perhaps unsurpassed—to be assumed in an example to illustrate the subject: a farm under such a course will be each year under the five following crops in about equal portions, viz., turnips, wheat or barley after turnips, first year's seedling grass after wheat or barley, second year's grass, and oats after the second year's grass: 300 acres of land under such rotation will require eight

horses to be kept. To determine the extent of cattle-lairs necessary to be provided on the same farm, let it be assumed one half the turnip crop to be drawn to be consumed by cattle in lairs, and the remainder to be eaten on the ground by sheep; the greatest number of beasts, after having been well grazed during summer, that could be thoroughly fattened on the very best crop of turnips would not exceed fifty.

Thus, in a system of husbandry in every way favourable for maintaining and increasing the productive power of the soil, under the most favourable circumstances of adaptation from its nature, and from high state of fertility for the growth of large crops of vegetables for winter feeding of cattle, a farm of 300 acres may require, in addition to the barn and its appendant conveniences not requiring variation of extent from size of farm or degree of fertility of soil, stabling for eight horses and lairs for fifty oxen.

It will, however, very rarely happen that a farm of the extent, and under the management described, can be efficiently worked by so few horses, and produce vegetables for winter fattening so many oxen as have been mentioned: for should the land incline in any considerable degree to *stiffness,* an additional pair of horses to the number named will be necessary; and should the quality of the soil be other than the best adapted for turnips, or any part be unsuited to the growth of that root, much fewer oxen than the number stated above could be winter fattened in a season. Probably from thirty to forty head of cattle, instead of fifty, would, under ordinary circumstances, be the number, in addition to sheep consuming one half the crop on the ground, that 60 acres of turnips grown on land of excellent quality would fatten during the whole season.

Whatever may be the system of management pursued on a tillage farm, the extent of the buildings that may be required may be easily estimated by a due consideration of the force required to work it, and the power of the soil to produce food for cattle in winter.

Of Arrangement of the Buildings.—The leading features to be attended to in the arrangement of the buildings of a farmery are simplicity, compactness without crowding, and the position of the several buildings being in strict accordance with the relative purpose of each as it depends upon that of another, so that all the operations carried on throughout the homestead may be performed at the least expense of time and labour.

Much has, from time to time, been written on the arrangement and construction of farm-buildings. Some authors have suggested useful plans, whilst others, some of whom esteemed as high authority on rural affairs, have recommended plans in many respects

very objectionable, arising, in most instances, from want of simplicity in arrangement. Farm-buildings have been recommended to be arranged in the form of a circle, or regular polygon of more than four sides; but no other than a rectangular arrangement can ever be applied to a farmery with advantage. In any building having oblique angles there must always be loss of space, besides which, oblique angles are always attended with inconvenience of shape.

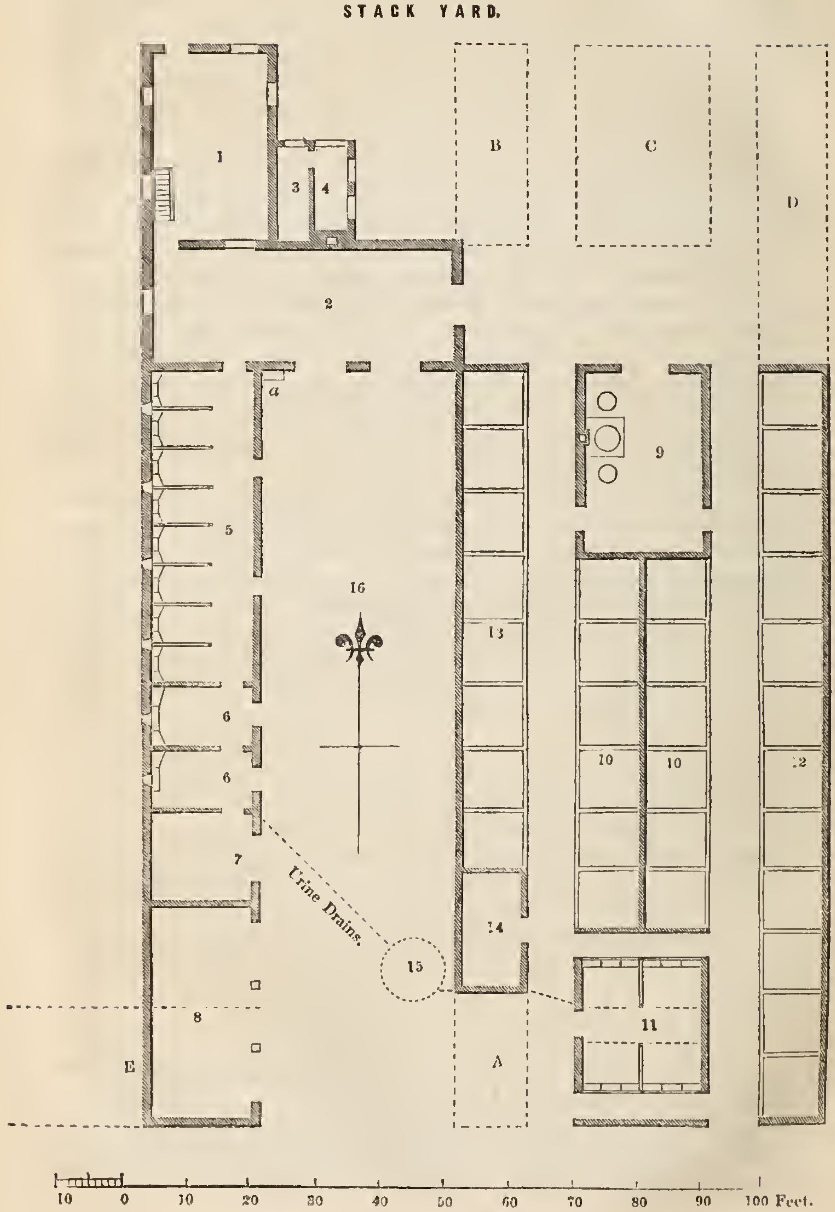
It is of the very greatest importance in designing a farmery that the principal buildings should be so arranged that, in the event of any future alteration in the size or mode of cultivation of the farm, an adaptation of any of the buildings to suit change of circumstances may be effected without derangement of the plan, or impairing the usefulness of any other building as to its relative position, if its purpose be not changed by the alteration. Oversight of such provision in planning a set of farm-offices has frequently occasioned much future expense, and is very often the principal cause of the inconvenience of arrangement so commonly to be observed where alterations (especially extensions) of farm-buildings have taken place.

To prescribe a rule by which the arrangement of farm-buildings will be applicable to all cases with equal advantage is impossible; as peculiarity of the form of the surface of the site—opportunity of applying a stream of water as the motive power of machinery*—and many other incidents may render a special modification of a plan necessary to obtain complete convenience, which, under circumstances not requiring special provision, might be in every respect the very best that could be devised. As a general rule, subject, however, to exceptions from a variety of circumstances, for good arrangement of farm-buildings the barn and its appendant conveniences should occupy and form a side of a rectangular court; the stables, sheds, and cattle-lairs should form the adjacent sides; whilst the dwelling-house, dairy, and domestic offices should occupy the fourth or opposite side of the rectangle. The interior of the rectangle should have an unintercepted exposure to the sun's rays at noon.

The foregoing observations, relating to the principal considerations in designing farm-offices, will be perhaps best elucidated by reference to a general plan: with which view, Plate I. is submitted as the ground-plan of a set of offices intended for a site

* Although the application of water by means of a water-wheel is unquestionably the cheapest, the steadiest, and in every point of view the best motive power for machinery, yet it very rarely happens that the situation where water-power can be used possesses other circumstances of advantage as to constitute it a desirable site for a homestead. Wherever fuel can be obtained at a moderate price a steam-engine in the farmery will completely supersede the necessity of the sacrifice of any important advantage for the sake of that of water-power to give motion to the machinery.

PLATE I.


STACK YARD.
1
3
4
B
C
D
2
a
9
5
16
13
10
10
12
6
6
7
Urine Drains.
14
15
8
11
E
A
10 0 10 20 30 40 50 60 70 80 90 100 Feet.

nearly level throughout the whole extent of the buildings; and which, according to what has been stated in the section treating of extent of accommodation, is adapted for a tillage farm of 300 acres, of a quality of soil suitable for the growth of turnips, whereon one half of the turnip crop, under a five-shift rotation of crops, is supposed to be applied to the winter fattening of oxen. The farmery is supposed to have a south aspect, and, exclusive of the barn and granary, to form a quadrangle extending 106 feet 6 inches from east to west, and 117 feet 6 inches from north to south.

PLATE I.

1. Barn of two stories.
2. Straw Barn or Fodder House, with a Granary above it on a second story.
3. Engine Room, and
4. Shed for engine boiler.
5. Stabling for 8 horses.
6. Two loose Boxes for stallions, brood mares, or sick horses.
7. Receptacle for stable dung.
8. Shed for implements.
9. Turnip House fitted with steam apparatus.
10. Cattle Lairs in a double range for 12 fattening beasts.
11. Cow House for 8 cows.
12. A single range of Cattle Lairs for 12 beasts.
13. Ditto for 8 beasts.
14. Calf House.
15. Liquid Manure Tank, to which the moisture from the stables, cow-house, and calf-house may be conducted by covered drains, the direction of which is shown by strong dotted lines.
16. Open Yard, 30 feet wide.

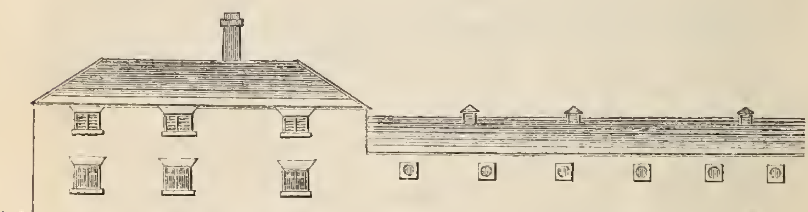
a. Watering Trough.

By inspection of this plate it will be perceived that the plan is capable of very considerable extension without in any way altering the general arrangement, or in any degree impairing the usefulness of any of the original buildings for the purposes for which they are designed: thus, the cow-house, No. 11, may be converted into 6 fattening lairs; the calf-house, No. 14, if extended to the site shown by the faint dotted lines, and marked A, will afford room for 4; the site marked B, 3; that marked C, 6; and that marked D, 5. So that by such extension, the accommodation will become lairs for 56 fattening cattle instead of the original provision for 32 fattening beasts and 8 cows; and, if required, the accommodation may, with equal advantage, be increased to 72 lairs by extension northwards. Provision for accommodation for cows, cancelled by the above mentioned alteration, will presently be shown. Then, again, by building a shed for implements to the westward, on the site marked E, increased accommodation of stabling for 5 additional horses may be as easily and efficiently provided as the extended accommodation for fattening cattle shown above.

PLATE II.

SOUTH ELEVATION.

NORTH ELEVATION



WEST ELEVATION.

WEST ELEVATION.

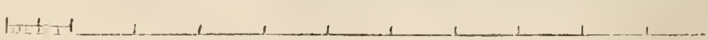
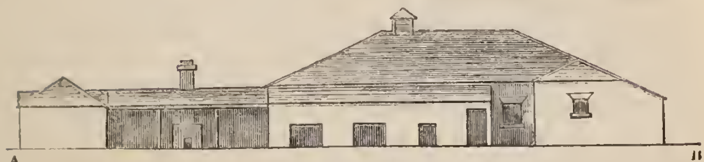


Plate III.

SECTION.



ELEVATION.

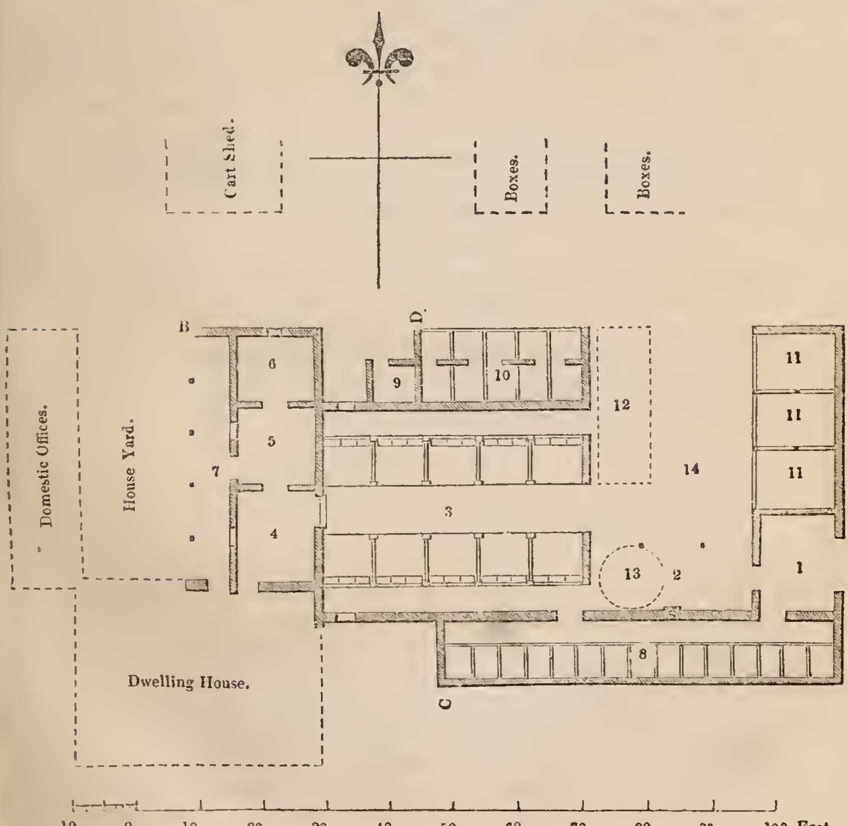


PLATE II.

represents elevations of the buildings of which Plate I. is the ground-plan, and which will be fully explained hereinafter, when the construction of the buildings comes to be treated of.

In the plan above referred to, tillage husbandry with the winter feeding of stock has almost alone been provided for; but it frequently occurs that the extensive tillage farmer has a taste for breeding cattle, or occupies a considerable portion of grass land suitable for the dairy husbandry in addition to his arable ground: in either case accommodation for 8 cows, suggested in the previous plan, will be insufficient. In order to render a treatise on the subject of the present essay of comprehensive use, it will be necessary to treat of the buildings required, not only for the purposes of tillage husbandry, but also of those that may be needed for the breeding of cattle, or for the dairy as a principal pursuit, and for both or either purpose to a more limited extent in connexion with the avocation of the agricultuist as the producer of the vegetable and animal food of mankind. The general plan about to be submitted will be suitable on a more extended scale, with a necessary portion of the buildings already enumerated, as the homestead of the cattle-breeder, or of the dairy-farmer; whilst on a more limited scale, with a larger portion of stabling for horses, and lairs for fattening cattle, it will form an important part of the accommodation necessary for the mixed pursuit of tillage with breeding or dairy husbandry.

PLATE III.

contains a ground-plan, elevation, and transverse section of a dairy for 20 cows: the plan consisting of—

1. Fodder House.
2. Shed in which may be a boiler or steaming apparatus.
3. Cow House for 20 cows.
4. Scalding Room, fitted with a boiler, and communicating with the cow-house.
5. Churning Room.
6. Milk Room.
7. Shed in which to expose milk vessels and dairy utensils, to dry and sweeten in the air.
8. Calf House.
9. House for poultry.
10. Sties for breeding or fattening swine, above which may be a loft for poultry.
11. Three Boxes for bulls.
12. Pit for dung.
13. Tank for liquid manure.
14. Open yard.

When the plan last referred to forms a portion of accommodation in connexion with that of an extensive tillage farm, the buildings comprised in it ought to be separated from those previously enumerated by a clear space of 30 feet southwards; and in order not to intercept the rays of the sun at mid-day from the stable-yard, the front of the bull-boxes ought to range in line with the wall of the westward range of fattening lairs.

It has previously been remarked, that circumstances may require the modification of any general plan for arrangement of

farm-buildings, however good such plan may be under ordinary circumstances; and peculiarity of the surface of the site was stated amongst other incidents as frequently requiring a special modification of arrangement. Such a necessity for deviating from the general principle of arrangement inculcated by previous remarks, and illustrated by the plans already submitted, came very forcibly within the experience of the writer in the design for a set of new farm buildings, which he prepared about eighteen months since for Mr. Laycock, at Lintz Hall, near Tanfield, in the county of Durham, and which have since been built.

In the case just referred to, the rapid rising of the ground prevented the application of the principle of arrangement previously herein suggested. To have adopted which, the alternative presented was either to have abandoned the most convenient site for buildings on the whole of the farm, or to have cut down the hill at a great expense, and attended also with other substantial disadvantages. After much consideration of the matter in all its bearings, a plan of arrangement suited to the circumstances of the site (principally suggested by Mr. Laycock himself) was adopted, and which is now submitted in

PLATE IV.

1. Barn of two stories, in which is a large thrashing-machine with dressing-machine, also a mill for crushing corn, seeds, &c., and a machine for cutting hay and straw into chaff, the whole of which is driven by a steam-engine of above six-horse power.
2. Straw Barn, above which provision is made for a granary on an upper floor.
3. House containing the steam-engine.
4. Ditto for the boiler.
5. Stable of five stalls, with a larger stall, which may be used as a loose box.
6. Turnip-house, in which is a steam apparatus for preparing food for cattle.
7. Cowhouse, fitted up for four cows, but which is sufficiently wide to contain five of an ordinary size.
8. Six boxes in which to fatten cattle.
9. Four ditto.
10. Two ditto.
11. Receptacle for the dung from the stable and cow-house.
12. Tank for receiving the urine from the stable and cow-house, into which also the soil from the privy, and the slops and dirty water from the cottage, are conducted by an earthenware pipe.
13. Cart Shed, above which is a loft for a poultry roost.
14. A House for ducks and such other fowls as do not roost upon a perch.
15. Coal-house.
16. Privy.
17. Open Yard behind the cottage.
18 and 19. Two rooms on the ground-floor of the cottage, above which are two chambers.
20. Dairy or Pantry.
21. Open Yard, 30 feet wide.
22. Weighing Machine, contained in a wooden house 8 feet square.
23. Open passage 8 feet wide.
24. Ditto.

a. Space in the Barn occupied by the thrashing-machine, &c.
b. Steaming Apparatus in the turnip-house.
c. Direction of a pipe communicating from the boiler of the steam-engine to that of the steaming apparatus in the turnip-house, by which the fuel for heating the furnace of the latter is saved when the engine is in use.
d. Direction of the drain conveying the urine from the cow-house to the liquid manure tank.
e. Watering trough.
f. Direction of conduit from the privy and the cottage to the liquid manure tank.

PLATE IV.

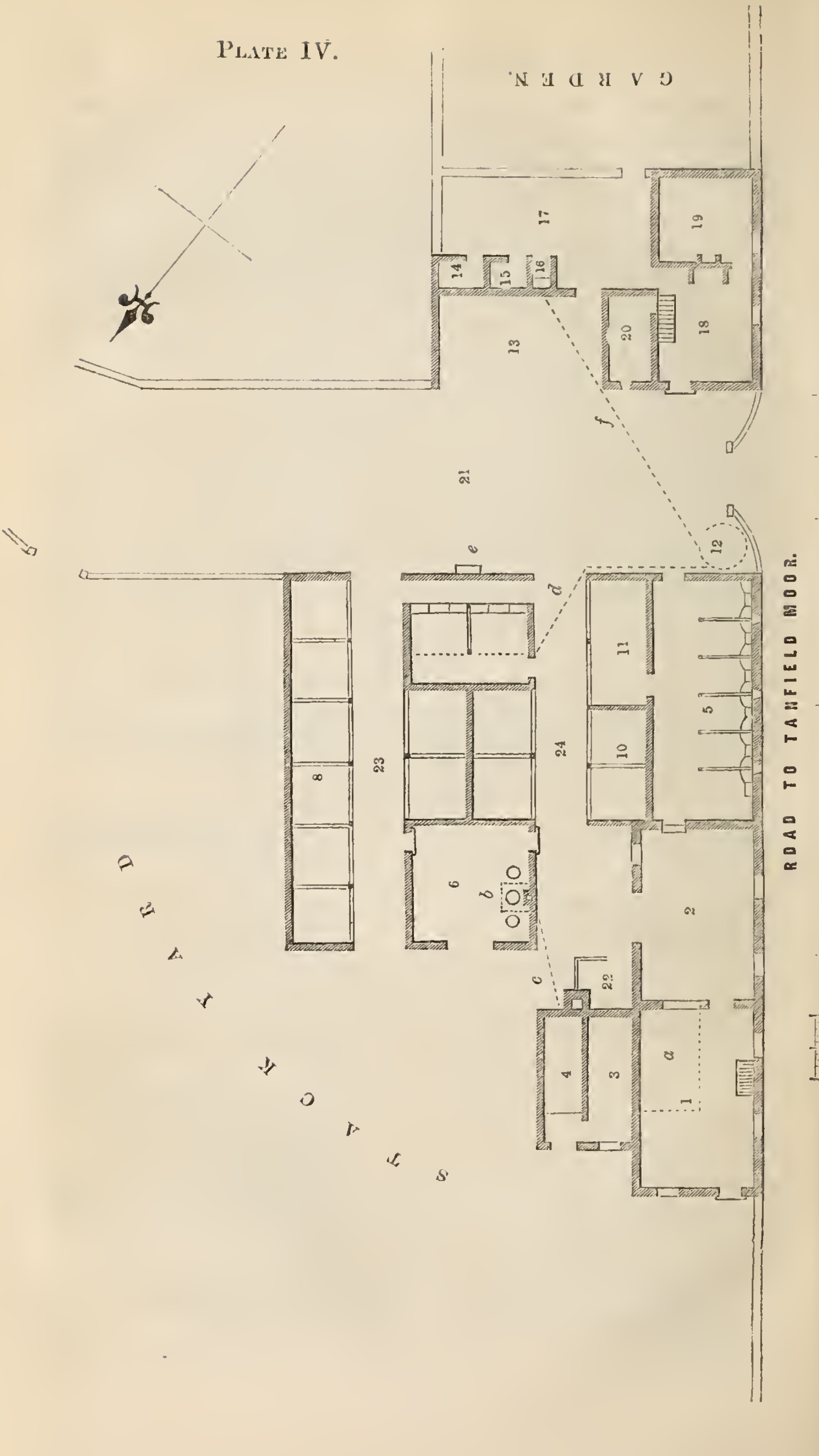


PLATE V.

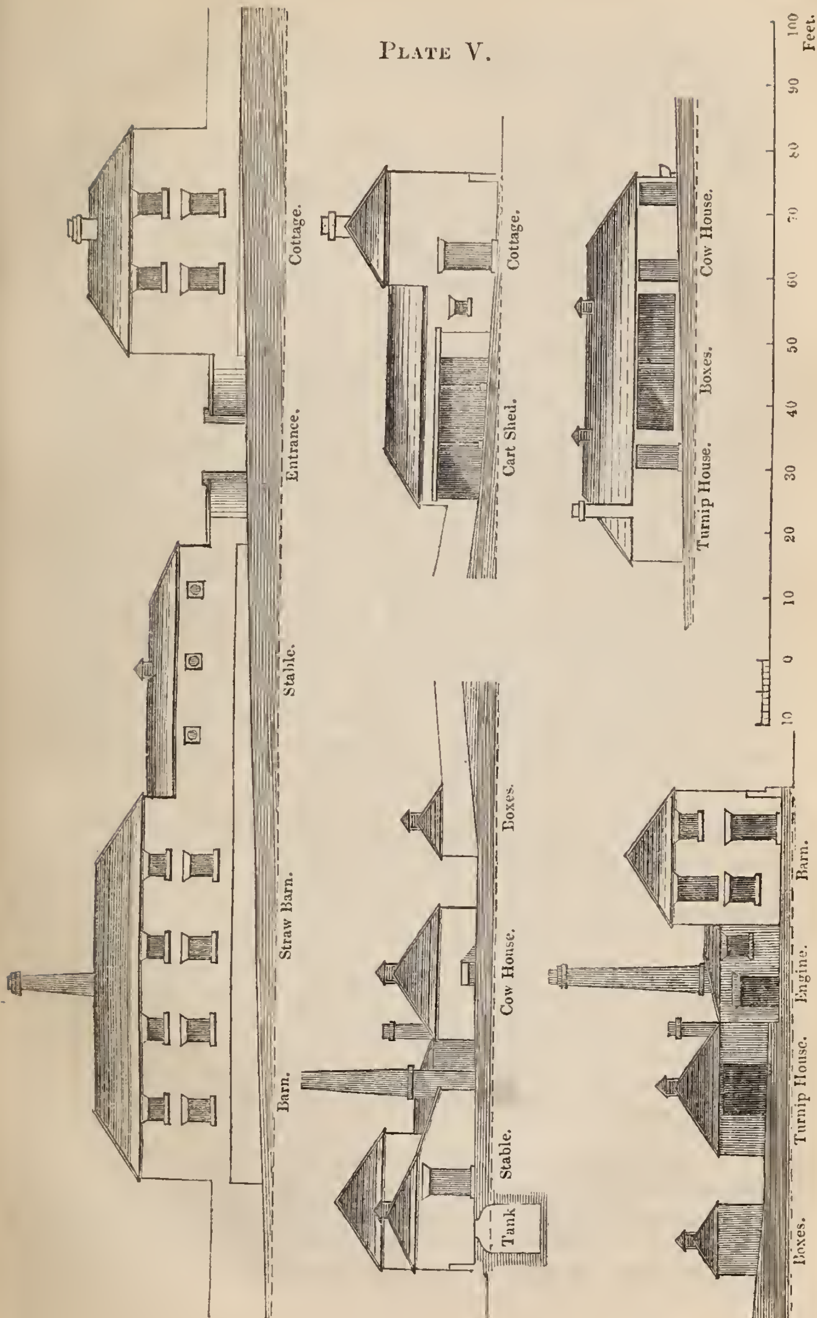

Cottage.
Entrance.
Stable.
Straw Barn.
Barn.
Cottage.
Cart Shed.
Cow House.
Boxes.
Turnip House.
Boxes.
Cow House.
Stable.
Tank
Barn.
Engine.
Turnip House.
Boxes.
10 0 10 20 30 40 50 60 70 80 90 100 Feet.

PLATE V.

is the elevation of the buildings of the plan contained in Plate IV., together with a natural section of the ground on which they have been erected.

The farmery in question comprises two plots of buildings, separated by a space 30 feet wide: one presents a frontage of 99½ feet along a township road, and extends backwards 75½ feet; the other has a front to the road of 35 feet, and extends 52 feet backwards. The walls of the buildings are all of brick from the surface of the ground; the roofs are hipped, covered with blue slate, and ridged with stone; and the whole furnished with eave spouts and wall pipes of cast iron, by which the rain water falling on the buildings is conducted to drains, and carried off the premises. The whole establishment, without any extra expense for attendance, presents the cleanliness and orderly appearance of a barrack yard—not anything to be met with that can in any degree whatever offend the senses of the most delicate person; affording a striking contrast to the filth and disorder usually prevailing in homesteads. A never-failing abundance of excellent water is supplied, by its own pressure, to every part of the premises in which it may be required, by the drainage of higher adjacent ground being intercepted by an underground reservoir at a proper level for the purpose. The internal fittings of the buildings, of the most appropriate description, and complete in every respect, were entirely contrived by Mr. Laycock himself; and in the specifications which will be recommended in a future section of the present essay, the ideas as to fittings are to be understood as derived from having seen those at the farmery at Lintz Hall.

After several months' trial, the farmery in question is found to answer every intended purpose so completely, that, in the cattle-feeding department, the food of 16 bullocks, consisting of chaff softened by steam mixed with linseed jelly, and raw turnips sliced, in alternate feeds, five or six times a day, is wholly prepared and served to the animals by a boy under 15 years of age, at wages of 5*s*. per week, and who moreover thoroughly dresses every beast with curry-comb and brush at least once a day. With such ease is the work just described performed, that it is the opinion of every one having witnessed the lad's procedure, that he is quite capable of bestowing the same attention on 24 beasts.

Of the Materials proper for the Erection of Farm-Buildings.—The walls of farm-buildings are usually formed either of brick or of stone; and in situations where neither of these materials can be obtained without considerable expense of carriage, walls may be formed of earth in the manner called by the French *pisé*,

which is very clearly and fully described in the Appendix to the first volume of Communications to the late Board of Agriculture.

Of the above-named materials, bricks, when made of the proper kind of earth and well burnt, form incomparably the best wall; as from their vitreous nature, good bricks do not absorb moisture, and are not liable to decay; from their shape they are capable of the most perfect bond in building, consequently forming the strongest wall; and from their close fitting they do not harbour vermin. The properties just mentioned are all of them of most essential importance in the building of farm-offices, and, when combined, furnish everything that can be desired for the purpose.

It is much to be regretted that a building material of such excellence as bricks should be subject to a heavy excise duty, which frequently operates to the exclusion of their use. The duty of 6*s.* 1½*d.* per thousand, which is charged upon building bricks of the usual size, amounts, in situations where clay is found suitable for the purpose and fuel cheap, frequently to more than half the cost of the manufacture; and wherever fuel may be expensive, or the distance of carriage considerable, the impost in question is inductive of a preference for a much less suitable, and, generally in the end, a much more expensive material for the erection of farm-buildings. When it is considered how close a connexion exists between good and sufficient farm-buildings and improved and profitable cultivation of the soil, the benefit to the community to be derived from a repeal of the duty on bricks cannot be doubted. At any rate, the question is suggested—does not the same reason exist for exemption of duty on bricks used for agricultural buildings as on bricks or tiles for draining? The tendency of both applications of the article is clearly the same—increase of the productive power of the soil.*

Stone is more frequently used for the walls of farm-buildings than bricks, because perhaps the first cost of stone walls is very commonly somewhat less than that of brick walls. Were the advantages of walls formed of good bricks, where such material can be obtained at a reasonable cost, to be fairly considered against any saving of outlay in the first instance in the use of stone, the bricks would, in most cases, deserve a preference. In making a comparison of the two materials, as to which a preference ought prudently to be given, it should be borne in mind that all stone more or less absorbs moisture, and thereby renders

* Should the Minister of Finance deem a total repeal of the duty on bricks inexpedient, a remission of the duty on such as might be used in the erection of farm-buildings on the estate on which such bricks are made would doubtless promote so important a matter to improved husbandry as good accommodation in buildings on farms.

the timber used with it in building more liable to decay than when used with brick. Many kinds of stone exfoliate, or crumble by the action of the atmosphere; and in rubble buildings of stone, the only kind of stone walls of which the cost is generally less than that of brick, unless the mortar be of the very best quality, the walls closely filled, have frequent thorough bonds, angles well coigned, and the returns of better workmanship than usually bestowed on rural buildings, stone walls are very much weaker than those of brick; whilst with any deficiency in quality, or decay of cement, however well the workmanship may be performed, rubble walls are a harbour for rats and mice.

The subject of the present section has perhaps, so far, been treated of at greater length than to many may appear needful; but the difference between the expense of brick and rubble stone walls which may appear in the estimates to be stated hereinafter, may mislead in favour of the latter, whilst in reality, all advantages considered, the former ought decidedly to be preferred in the erection of farm buildings.

The timber best adapted for building purposes is red fir from Norway or Sweden.

Pillars and upright supports are best of cast iron. Blue slate is, of all materials, the very best covering for roofs. Tiles, and artificial roofing made of Roman cement in imitation of stone, are neither of them to be recommended, as, being absorbent, they are liable to disintegration of their substance by the action of frost. The different kinds of roofing which have of late years been much puffed in advertisements under the appellation of asphelted felt, &c., have also nothing in their properties to recommend them for permanent agricultural buildings; they require sarking under them, and at best they make but an unsightly, and frequently a very indifferent covering. The article in question may, however, serve sometimes for erections of a temporary nature; but where cheapness may be an object for the covering of sheds and small building, reference is made to a mode of covering described in Appendix A, hereunto annexed. The different materials best adapted for the erection of farm-buildings having been noticed, the dimensions, construction, specification, and estimate of the cost, will next require consideration. But before treating of the different buildings comprised in the plans to which reference has already been made, it may be remarked that hipped roofs are to be preferred to roofs with gables, as being neater in appearance, snugger from the action of the wind, and equally economical; and that the proper slope of roof is that on which a heavy body will just slide on its surface; which, on a slated roof, is when the pitch, or height of the ridge above the walls, is one-third the outside breadth of the building.

Of the Barn (for plan, *vide* Plate I. No. 1; for elevation, *vide* Plate II.).—The immense building which in former times was considered as an indispensable appurtenance to a tillage farm, and intended to contain the whole grain crop in the sheaf, is now very properly out of repute, as grain in sheaf is found to keep much better in stacks upon proper stands in the stack yard than within the walls of the barn; and buildings of such magnitude are moreover very costly to erect in the first instance, and expensive to uphold in repair afterwards. Although unnecessary size of buildings of a farmery is by no means to be recommended, yet a barn in addition to sufficient room for the proper performance of the operations to be carried on in it, should have space to stow at least 100 bushels of wheat in sheaf, in order that spare time may be taken advantage of to have such quantity of corn transferred from the stack to the barn, and so be ready to be thrashed whenever straw may be wanted, or wet weather may prevent the advantageous employment of the servants out of doors.

If containing two stories of moderate height, a building of 30 feet long, and 21 feet wide, including walls, will be found sufficiently large for the purposes of a barn for a farm of almost any extent—certainly for one of 300 acres of tillage. The proper height may be 9 feet for the lower story, and 7 feet for the upper, making, including the floor of the second story, 17 feet for the height of the walls of the building. The foundation of the barn should be sunk 2 feet below the surface of the ground, and if of stone under a brick wall, it should be at least 24 inches thick; and if under a stone wall, it should be 30 inches thick. The walls of the first story, if of brick, should be 2 bricks in thickness, leaving a clear breadth inside of 18 feet; and, if of stone, 24 inches thick, leaving 17 feet for the inside breadth: those of the upper story should be 1½ brick, or 20 inches thick, according as they are brick or stone: in the former case leaving 18 feet 8 inches, and, in the latter, 17 feet 8 inches of clear breadth. The apertures in the lower story are, in the north wall, for a door and a window, both 4 feet wide, the former 7 feet and the latter 4 feet high; in the east wall, one for a window, 4 feet wide by 4 feet high; in the west wall, two for windows, each 4 feet wide by 4 feet high: and in the south end of the building, communicating with the straw barn (No. 2), one for a door, 4 feet wide by 7 feet high; and another, partly extending into the second story opposite the thrashing machine, 5 feet wide by 5 feet high, at about 2 feet from the east wall, and at such a height from the ground as to afford a proper slope for a screen on which the straw may slide into the straw barn on leaving the machine. Both the apertures last mentioned to have *lintels* of Christiania deals, and the latter to have a *cill* of the same. The openings

in the upper story are, in the north wall, for a door, 4 feet wide by 6 feet high, over the window; and for a window, 4 feet wide by 3 feet high, over the door in the lower story; in the west and east walls, for the same number of windows as in the lower story, immediately above them, and of the same breadth, but only 3 feet instead of 4 feet high; and for a door, in the south wall communicating with the granary (above the straw barn), 4 feet wide by the height of the wall. The openings in the external walls to have dressed stone heads 1 foot deep and 9 inches thick; those for the windows to have cills, also of the same, 6 inches deep by 9 inches thick; the doorway of the lower floor in the north wall to have a cill or step of stone, and the apertures for both doors and windows to have lintels of Christiania deal or English oak. The floor of the lower story may either be dressed flags, concrete (to be described in the Appendix B), or boarded with Norway battens slit into half their thickness, and laid upon sleepers of battens on edge at 6 feet apart. All the materials just mentioned are well adapted for the purpose, and perhaps of nearly equal cost; and that, therefore, will be preferred which can most easily be obtained. The floor of the upper story to be of Norway battens slit into half their thickness, laid upon joists of 9-inch Christiania deals, 18 inches apart, from centre to centre, and resting on a wall plate of 9-inch deal. The principal rafters of the roof, with the tie-beam, to be formed of Norway battens; the ridge and hip pieces of half thickness of batten; the purlines and small rafters to be of one-third breadth of batten; and the wall plate of the upper story to be 9-inch deal. The principal rafters to be not more than 10 feet apart, the small rafters 18 inches apart, from centre to centre. The roof to be covered with blue slate upon laths, cut out of Christiania deal, $1\frac{1}{4}$ inch broad by $\frac{3}{4}$ inch thick; and the ridge and hips to be furnished with stone ridging. The communication between the lower and upper story to be by means of a fixed step ladder, 2 feet 9 inches wide, furnished with a hand-rail, in the position shown on the plan, through a hatch in the floor of the upper story, 3 feet wide by 5 feet long.

As the fittings of this and the buildings next to be described will be alike, it will be as well to defer the specification of them until after treating—

Of the Straw-barn and Granary (for plan, *vide* Plate I. No. 2, for elevation, *vide* Plate II.).—Necessarily, in immediate connexion with the purposes of the barn, are those of the straw-barn and granary; which accommodations of the farmery form, in the plan referred to, the lower and upper story of a building under the same level of ridge of roof, adjoining at a right angle to that for which a specification has been given, and which occupies a

space, including walls of 49 feet 2 inches in length, and 21 feet in breadth.

As the height of the stories, the thickness of the walls, the floor of the second story, and the roof ought, in every respect, to be similar to what has already been described; it is then only necessary to specify those particulars of the building in question in which it differs from that already treated of.

The apertures in the north wall of the straw-barn, separating it from the lower story of the barn, have already been described; those in the other walls are as follows: one in the east wall for a door 6 feet wide and 8 feet high, to have a pan-piece of Memel fir timber 12 inches square; one in the west wall for a window, to be uniform with the apertures for windows in the lower floor of the barn; and, in the south wall, two for open cartways, each 8 feet wide by 8 feet high, separated by a pier 3 feet wide and of the same thickness as the other walls, and to have pan-pieces of Memel fir timber 12 inches square; also one for a door 4 feet wide by 7 feet high, communicating with the stable (No. 5), to have a lintel of Christiania deal. Hard stone, broken into small pieces, and well rammed upon freestone chips and rubble, with stone cills at the openings for the doors and cartways, will form a very suitable floor for the straw-barn. The openings in the walls of the granary, or story over the straw-barn, are—one for a door, communicating with the upper story of the barn, and already described; two, for one window each in the east and west walls; one in the north wall, for a window; and three for windows in the south wall. The specification for the apertures for the whole of the windows just enumerated are to be in every respect the same as that for windows in the upper story of the barn.

The doors most proper for the building now treated of, are what are called ledged-doors, and should be made of Norway battens, slit into half their thickness, with door-frames of Christiania deal, 4½ by 3 inches; 3 inches of the first-mentioned dimension to appear within the opening at half a brick distance from the external surface of the wall when of brick, or placed in a rebate of 1½ inch, at 6 inches from the external surface of the wall when of stone. The door on the lower story of the barn, in the north wall, will most conveniently be made in two parts of its length; and that in the upper story in the same wall will be best a folding-door, opening from its mid-breadth. The door best adapted for the aperture 6 feet wide, in the east wall of the straw-barn, is a sliding-door, furnished at both bottom and top with small friction rollers or pullies, running on iron rods. The whole of the windows for the lower story of the barn, and also that for the west wall of the straw-barn, may

be exactly alike, and a construction of window well adapted for the purposes of the building may perhaps be easily understood, by assistance of the following figures :—

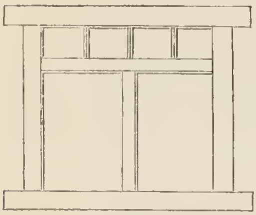


Fig. 1.

Fig. 2.

Fig. 1 represents a front view or elevation of the frame of the windows in question, and will be best of Christiania deal, 4½ by 3 inches; 3 inches of the first-mentioned dimensions to appear within the aperture in the wall, and at the same distance from its external surface as previously specified for door-frames; a portion of the space of the frame in its upper part, 9 inches high, to be separated by a transom 3 inches square, and divided into four panes by moulded vertical bars; the space below the transom to be divided by an upright mullion 3 inches square, and furnished with ledged-shutters ¾ inch thick, which, closing into a rebate 1½ inch deep, will shut with the ledges of the shutters flush with the inside surfaces of the frame, transom, and mullion. Fig. 2 represents a vertical section of the window just described, with head, lintel, cill, and portion of the wall. The purposes of the upper story of the barn and those of the granary requiring constant admission of air and exclusion of wet, windows with Venetian lattices will be the best adapted for the purpose. The frame ought to be the same as that last described, and its space divided in the whole height by an upright mullion of 3 inches square; the lattice-frame of the shutters may be 2 inches square, and the lattices ¾ inch thick, 2 inches apart, and slanting half-square downwards. The shutters so constructed and hung, that, closing into a rebate 2 inches deep, will shut flush with the inside surfaces of the window and mullion. Fig. 1 below is a front view or elevation of the window described, and Fig. 2 its vertical section, with the head, lintel, cill, and a portion of the wall.

A hatch in the floor of the upper story of the barn, for hoisting corn through when thrashed and dressed, to be stored in the

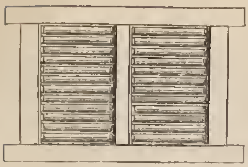


Fig. 1.

Fig. 2.

granary, and another hatch in the floor of the granary, for hoisting or lowering corn or other articles through, from, or to the straw-barn, it need scarcely be remarked, will be found most useful conveniences.

Of the Engine-house and Boiler-shed (for plan, *vide* Plate I., Nos. 3 and 4; for elevation, *vide* Plate II.). The steam-engine, from its compactness, its efficiency, economy of its application, and adaptation to any situation, is coming much into use as the motive power of agricultural machinery, wherever coal can be obtained at a reasonable price; and, in consequence of its unrivalled fitness for the purpose, is assumed to be the motive power of the machinery of the farmery now being treated of. And no doubt the diffusion of coal at a reasonable price throughout the kingdom, by means of railway communication, will render this most valuable power available in districts even the most remote from where the mineral fuel is found.

In a fixed steam-engine, its weight being no objection, the strength of all its parts may be much greater in proportion to its reputed power than might be consistent in an engine expressly constructed to be moved about; hence a fixed engine will be steadier in its action, more effective in power for its size, and more durable than a portable one, and therefore always to be preferred wherever its use is required in one and the same place.

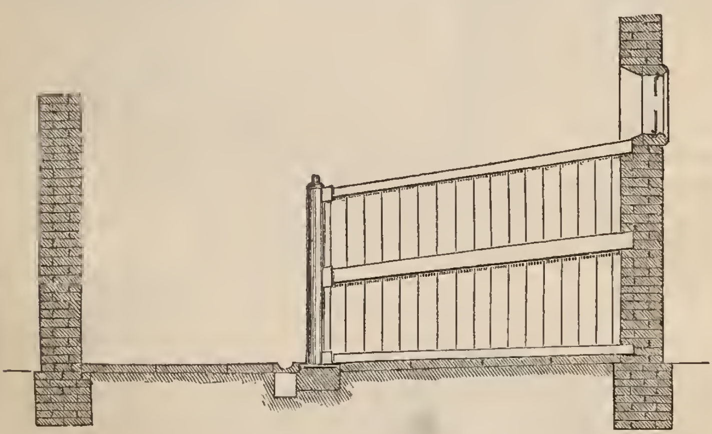
The proper position for a steam-engine is as near as possible to the work requiring the greatest amount of power, which, in a farmery, is the thrashing machine. The building containing the engine and boiler, in the plan referred to, is therefore placed adjoining the east wall of the barn, to which the roof may fall at 1 foot below its eaves; and 15 feet by 12 will be a sufficient space for a building for the purpose to occupy. The height of the east wall of the boiler-shed may be 8 feet, and the chimney of the boiler-furnace ought, in the position here recommended, to be built with the north wall of the straw-barn and granary.

The proper construction of a building for the purpose of that in question is so obvious as to render further remarks unnecessary.

Of the Stables (for plan, *vide* Plate I. Nos. 5 and 6; for elevation *vide* Plate II.).—Too little attention is generally bestowed on the construction of farm-stables, by which horses are frequently more liable to injury in their health and usefulness than might arise from the artificial treatment to which these animals must, in some degree, be necessarily subjected in order to command their labour economically. Although it would be out of place to fit up the farmer's stable in the style of elegance frequently adopted by the wealthy for their pleasure-horses, yet there are certain properties essentially common to all stables wherein the preservation of the health and usefulness of the animals is kept in view, whether for the plough-horse, the carriage-horse, the hunter, or the racer. A stable, to be perfect for its purpose, should be well lighted, perfectly dry both from above and below, have the means of preserving cleanliness at all times, and have perfect ventilation and means to regulate the temperature without subjecting the animals to direct draughts. The reasons for the properties in a stable just mentioned are forcibly pointed out by the late Mr. Youatt in his treatise on the horse, to which excellent work the reader is referred for much valuable information relating to the management of that noble animal. As saving of space need never be an object in the site of a farmery, the stable, or any other building in which live-stock is kept, should never be lofted. The uninterrupted space of the roof being included in that of the building renders a less height of wall necessary, and ventilation more perfectly and easily attained.

The position of the stable should be as near as possible to that part of the farmery from whence the provender and straw is supplied. In the plan referred to it is placed adjoining to the straw-barn. The proper length for a stable is 6 feet for each horse it is intended to contain, and the breadth should not be less than 14 feet within the walls. The stable in the plan, intended for eight horses, is 48 feet of clear length, and 18 feet in breadth, including the thickness of the walls. The height of the walls may be 9 feet from the floor, and 1½ brick when the walls are of brick, or 20 inches if of stone, will leave an available breadth of stable of 15 feet 8 inches in the one case, and 14 feet 8 inches in the other. In a stable of the size described, there should be two doors in the west wall, the construction of which, with their frames, may be similar to those already described, and the apertures for them furnished with dressed stone-heads and cills. The stalls should be 9 feet in length, leaving a

space behind the horses of 6 feet 8 inches, or 5 feet 8 inches, according as the wall may be of brick or stone, with a declivity from the front backwards of 2 to 3 inches in their length of 9 feet, behind which there should be a channel running the length of the stable, furnished with a cast-iron grate to each stall, through which the urine may pass into a covered drain below, and conveyed from the building by means of an earthenware socket-pipe to the liquid manure-tank (No. 15). In order to prevent the horses from injuring each other by kicking or biting, the stalls should be separated by a close partition in the whole of their length, which should be at least 6 feet high at the head, and 5 feet high at the lower end of the stall. The partitions spoken of may be formed of Norway battens, slit into half their thickness, clamped together by stuff of the same thickness at the top, the middle, and the bottom, fastened by a wooden pin through each upright batten, and held at the lower end of the stall by a hollow cast-iron pillar $5\frac{1}{2}$ feet high and 6 inches external diameter, set with a square flange into a plugged block of stone; the pillar being furnished with flanges forming grooves to receive the ends of the cross-battens or rails, which should be secured therein by means of pins passing through holes drilled in the flanges for the purpose. The accompanying figure will perhaps assist in conveying an exact idea of what is described respecting the stalls.



The mangers and racks are best of iron: those adopted by Mr. Laycock in his farm-buildings at Lintz, of which a plan and elevations have been previously referred to, are to be highly recommended for the purpose, and consist of a cast-iron rod about $1\frac{1}{2}$ inch diameter, forming the top part of the manger, which is in the mid-width of the stall, and extending from the front of the

manger to each side of the stall, curving a little outwards at the ends. At the under part of the rod, extended beyond the manger, is a flange, to which ½-inch malleable-iron rods are riveted, and also to a piece of flat iron against the wall, and which forms a rack at each side of the manger, the top of the whole being 3½ feet, and the bottom of the rack about 1½ foot above the floor of the stable, the whole secured by means of screw-bolts passing through the wall at a distance from each other of the length of the manger, in front of which are rings to which to fasten up the horses. In order to secure proper ventilation, each stall should be provided at its head with a grate the size of a brick, built into the wall about 3 inches above the floor. Any direct draught on the legs and feet of the horses may be prevented by placing a little litter in front of the aperture into the stall. A glazed window, made of cast-iron of a circular form, swinging from a vertical to a horizontal position, in a frame also of cast-iron set in a stone case, is a very suitable light for a stable, and it may be placed in the wall at the head of the horses, immediately above the alternate divisions of the stalls, by which each window furnishes light and air to two stalls. The construction of the windows referred to may be easily understood from the figures below. Fig. 1 represents a front view or elevation of the circular window—say 20 inches diameter—in a stone case 27 inches square and 6 inches thick, with a groove in its thickness to admit the frame, on which the window swings on pivots at the extremities of its horizontal diameter, and within which it closes when shut. The face of the stone case may project about an inch beyond the external surface of the wall, and be ornamented with a moulding around the frame. The inside diameter of the aperture may, for the better admission of light, be increased to 26 inches. Fig. 2 is a vertical section of the window, the frame within which it closes, the stone case, and part of the wall.

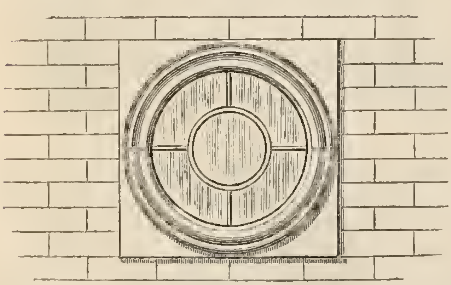


Fig. 1.

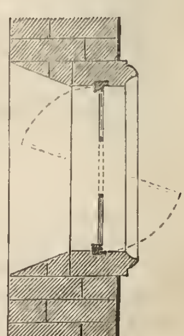


Fig. 2.

Should the window above described be deemed too expensive, a sliding-bar shutter, having a row of small glazed panes above, may be substituted. The reason for recommending windows for a stable being placed in the wall at the head, instead of the usual position in the wall opposite to the bottom of the stall, is that the air may be more immediately applied to the breathing of the horses, and the light being thereby furnished direct instead of reflected, which latter mode of furnishing light is injurious to the sight, and frequently the unsuspected cause of blindness of horses. The roof should be furnished at its ridge with a cupola of wood, the sides of which should be latticed, to carry off heated and vitiated air generated by the breathing, perspiration, and excrements of the horses. Fig. 1 below is the front view or elevation, and Fig. 2 the vertical section of such cupola. The floor may be of flags, or paved evenly with blocks of any hard stones as can conveniently be obtained, well squared and fitted close in their joints.

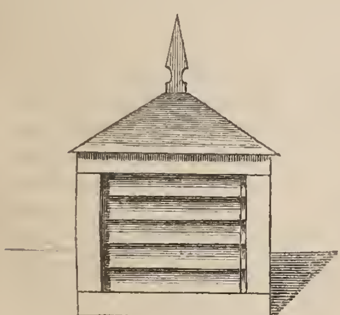


Fig. 1.

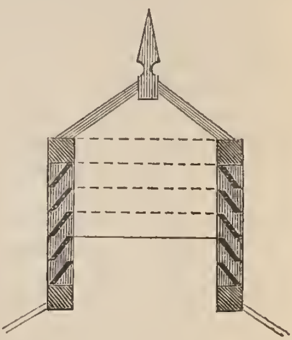


Fig. 2.

The offices marked 6 on the plan are intended for two loose boxes for stallions, foaling mares, or sick horses, each to be 9 feet wide in the clear when separated from the stable (5), and from each other by brick walls of one brick in thickness: such walls to be 9 feet high, and have a door in each 4 feet wide by 7 feet high. Each box to have an external door to the yard (16), same as the external doors previously described; and the box next the dung-pit (7) to be separated from that conveniency by a brick wall carried up to the ridge 1½ brick thick, when that material is used, or 18 inches thick when the buildings are of stone; the last-mentioned wall having a door communicating with the dung-pit 4 feet wide and 7 feet high. The boxes to be furnished with windows, a cupola in the ridge, fitted, and paved in the same manner as the stable.

Of the Dung-pit (for plan, *vide* Plate I., No. 7).—In the plan

referred to the dung-pit is marked 7, and adjoins the loose boxes and stables, having a communication by a door from one of the former. This conveniency of the farmery should be separated from the offices to which it adjoins by walls, from its floor to the ridge, 1½ brick thick when that material is used, or of a proportionable thickness when the buildings are of stone. It may be sunk 4 or 5 feet below the surface of the ground; and, wherever bricks can be obtained, it should be lined with that material, half-brick thick at least, well pointed for 6 inches below the excavation. If the bottom of the excavation be sound clay, impervious to water, nothing more will be required to be done to it than to beat it firm; but if, on the contrary, the soil be loose and permeable by moisture, it will be necessary to cover the bottom 6 inches thick with a concrete substance described in the Appendix C. The dung-pit should have an aperture in its western wall 6 feet wide, and at 7 feet high have a pan-piece of Memel fir timber 12 inches square, the wall then carried up above it to the same height as wall of the stable, and the opening to have a cill of deal 9 inches wide upon a wall 1 foot above the surface of the ground.

Of the Implement and Cart-Shed (for plan, *vide* Plate I., No. 8).—The last in the range of buildings extending from north to south on the west side of the plan of the farmery proposed, and adjoining the dung-pit (71) on the south, is the implement and cart-shed, occupying a space, exclusive of the thickness of the wall separating it from the dung-pit, of 34 feet in length, and, including the front and back wall, 18 feet in breadth. The walls to be of the same thickness and height as those of the adjoining offices, previously described, but open in front to the height of 7 feet, having cast-iron pillars 8 feet apart, 6 feet long, and 4½ inches external diameter, upon stone plinths, and supporting a pan-piece of Memel fir timber 12 inches square, above which a wall is to be carried up to the same height as the west wall of the adjoining offices. The floor may be of hard stone, broken small, and well rammed on free-stone chips or rubble.

The roofs of the stable, loose boxes, dung-pit, and implement and cart-shed to be all of the same span, and under the same ridge, at a pitch of 6 feet; hipped at the south end; formed of Norway red battens, in the same manner as the roof of the barn, straw-barn, and granary; covered with blue slate; and finished with stone ridging.

Of the Cattle-Lairs and their appendant Conveniences (for plan, *vide* Plate I., Nos. 9, 10, 11, 12, 13, and 14. For elevation, *vide* Plate II.)—Having, in the foregoing pages, treated of the dimensions and construction of the several buildings of the farmery in which the grain crop is prepared for market, the labouring

beasts are kept, and the implements for the cultivation of the soil are preserved from the deteriorating effect of the weather, it next comes in course to notice the same topics relating to the conveniences of the farm-stead in which the green crops may be, by consumption by fattening cattle, converted with the greatest advantage into aliment for mankind, and in which the refuse of the grain crops and the *egesta* of animals may be best appropriated to means of restoring exhausted fertility, and of increasing the natural productive powers of the soil.

In passing to the more immediate subject of the present section, it may not perhaps be deemed as altogether out of place to remark, that recent legislative measures will render every improvement in agriculture of increased importance, and, to those most interested in the pursuit, can any branch of rural economy be of more consequence than that above alluded to? The generally imperfect management of fattening stock, and the negligent preparation of manure so prevalent in times past, cannot enable the husbandman of Britain to meet, without diminution of capital, the unrestricted competition of foreigners in the British market in every kind of produce of the soil which he will henceforth have to encounter. The excrements of a few half-fed wintering cattle, and the litter of an open yard exposed to the alternate effects of rain, wind, and sunshine, will do little in raising such grain crops as to enable the British farmer to maintain, much less to promote, a profitable employment of his capital and of native industry in the cultivation of the soil. Nor will the estate of the landed proprietor be supported in its present value in the absence of accommodation for the fattening of cattle with the greatest economy, and convenience for preparing manure without waste of its fertilizing properties.

The essential conditions on which the fattening of cattle can be attained with the greatest economy are, warmth, quietude, wholesomeness of atmosphere, and cleanliness. And of all accommodations that have probably ever been invented for the feeding of oxen, none has so completely answered the principal object of converting the vegetable productions of the earth into food for mankind, in the shape of flesh, as the plan of feeding in boxes or loose stalls, first suggested by Mr. John Warnes of Trimingham in Norfolk: nor does any plan more completely fulfil a secondary, but scarcely less important, object—the raising manure of the best quality with the greatest economy—than the accommodation alluded to. There cannot exist in the mind of any individual who may have witnessed the feeding of cattle in boxes, *properly carried out*, a doubt of its being a most effectual mode of providing due shelter, perfect freedom from molestation, and complete comfort to the animals—all conditions most essential to rapid thriving: nor can

any one behold the accommodation without being thoroughly convinced of the great economy in collecting the *egesta* and preserving it in the very best state for its purposes, and yet without the least exhalation of effluvia. Whatever may be supposed, those who have not seen the box-feeding system in operation are hereby assured by the writer, who has carefully watched its effect, that it is in every respect consistent with perfect cleanliness and perfect health of the beasts; and he must, without hesitation, state his belief, that, whenever any objection has been raised to the system, it has been induced from having seen boxes of improper construction and fitting, or perhaps from excess of moisture produced from rain from above or from springs from beneath. As to the latter observation respecting excess of moisture, the writer is certain of the fact, that a sufficient quantity of dry litter supplied three or four times a-week, to keep the animals clean from the solid excrement, is sufficient to completely absorb the whole of the urine they void. Before having had an opportunity of judging correctly of the fact, the writer was certainly of opinion that supersaturation of the litter with urine would soon take place, but thorough conviction of the contrary has been induced by actual experience.

The superiority of the system of feeding cattle in boxes over either tying up in stalls or going loose in the fold-yard, consists most evidently in its combining the shelter of the stall with much of the freedom of the yard, without the liability of molestation from companion beasts, not forgetting the injury heifers in a fat state are liable to from mounting each other when in season to take the bull. The writer is so thoroughly convinced of the important advantages to be derived from feeding cattle in separate boxes, under cover of a roof, that he suggests that system as the best he ever witnessed or heard of in the plan he submits to the Society in competition for their valuable premium for the best essay on farm-buildings.

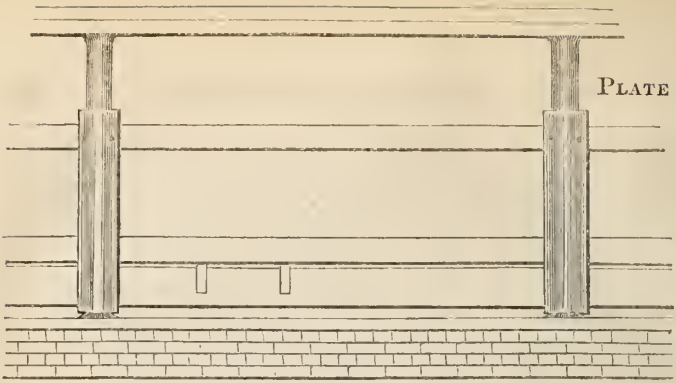
The cattle-feeding department in the proposed plan occupies the eastern side of the farmery, and consists of a turnip or root-house (9), in which should be a steaming-apparatus—a double tier of feeding-boxes (10)—and a cow-house (11), all in a continuous range between two ranges of boxes in single tiers (12 and 13), and at 8 feet distance from each; at the southern extremity of the range of boxes (13) is a calf-house (14).

The turnip-house (9) occupies a space, exclusive of the wall, 1 brick thick, separating it from the double tier of feeding-boxes (10), of 29 feet 8 inches in length, and, including the thicknesses of the walls, 20 feet 8 inches in breadth. The north end and the side walls of this building should be at least 7 feet 6 inches high from the surface of the ground, and 1½ brick thick, and have an

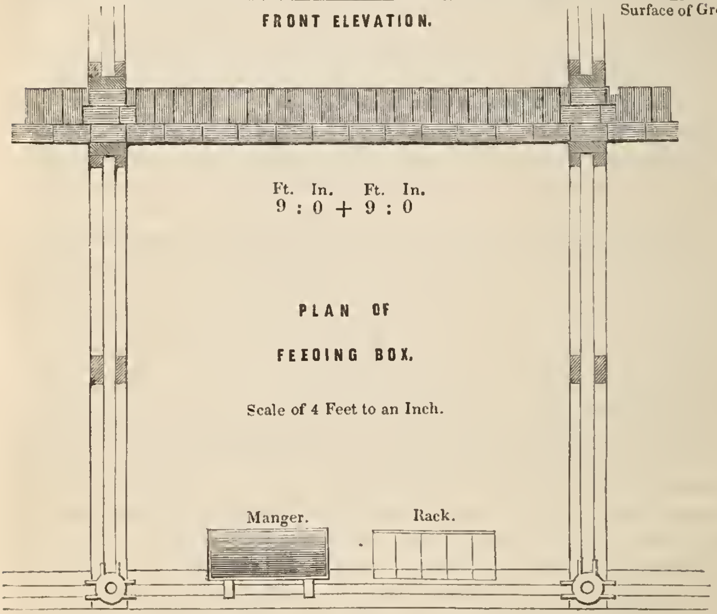
aperture in the north wall of 8 feet wide and 7 feet high, with a pan-piece 6 inches deep, and furnished with a sliding door; an aperture of 3 feet 6 inches wide and 7 feet high, with a lintel 3 inches thick and a cill rising 3 inches above the ground, furnished with a door and frame similar to those before described, in each side wall at 3 feet from the wall separating this office from the feeding-boxes; and a chimney in the west wall, midway between the door and north end wall, for the furnace of the steaming apparatus. The floor of this building will be best of flags.

Adjoining to the last described office, and separated from it at one end, and from the cow-house (11) at the other, by a wall 1 brick in thickness carried up to the height of the side walls of buildings mentioned respectively, are twelve boxes (10) in which to feed cattle, arranged in two tiers or rows facing in opposite directions, and separated by a wall 1½ brick thick, running lengthwise, and carried up to the same height as the walls before described. The proper size of feeding-boxes to contain a large bullock is 9 feet square in the clear, and their construction may, perhaps, with assistance of the plan, elevation, and section, on a scale of 4 feet to an inch, given in Plate VII., be understood without difficulty from the following description. The boxes should be sunk 1 foot below the level of the surface of the ground, and separated from each other by a wall 1 brick thick and 2 feet high from their bottom or floor, and also have a similar wall in front, upon both of which there should be a wall-plate of deal 9 inches wide and 3 inches thick, bringing the entire height of the division to 2 feet 3 inches above the level of their floor, and that of the front to 1 foot 3 inches above the level of the surface of the ground. At the intersection of the front by the divisions of the boxes there should be cast-iron pillars 6 feet long and 4½ inches outside diameter, supporting a deal similar to the wall-plates before described, to carry the roof; and, at each end of the range, there should be an upright deal, with its thickness outwards, laid flat to the walls separating the range of boxes from the turnip-house and cow-house, and connected with the deals at top and bottom by a mortice and tenon. The cast-iron pillars should have two longitudinal flanges forming a groove 2½ inches wide and 2 inches deep, two such grooves in the direction of the length of the range, and one in the direction of the cross divisions separating the boxes on each pillar. The upright deals at the ends of the range should have half the breadth of a batten firmly nailed on the breadth of deal at 2½ inches apart, forming a groove in the middle of the breadth of the deal throughout its length, of 2½ inches wide and 2½ inches deep. The flanges of the pillars and the half-battens on the deals should have holes drilled at stated distances to admit bolts or pins for the

PLATE VII.



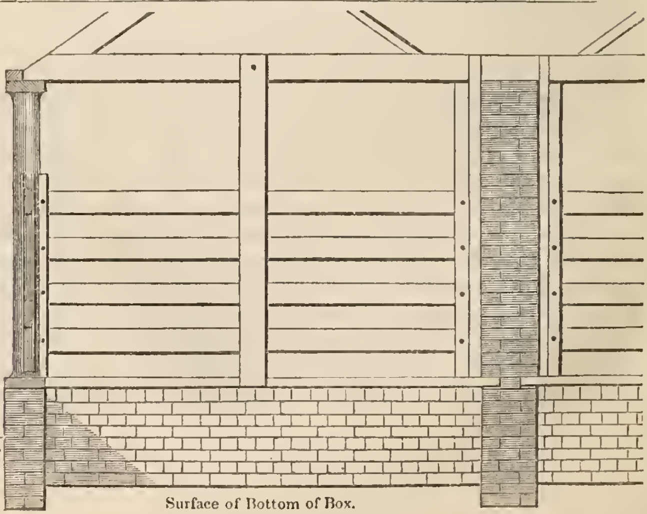
FRONT ELEVATION.



PLAN OF

FEEDING BOX.

Scale of 4 Feet to an Inch.



TRANSVERSE SECTION.

purpose hereinafter to be explained. The roof should be formed of Norway redwood battens in a manner easily to be understood by an inspection of the transverse section given in Plate VII. There should be a couple and tie beam, which should be of the full size of batten, over each division between the boxes. The ridge-piece may be formed of battens slit into half their thickness, and the rafters, purlines, and pole-plate of one-third of the breadth of a batten. Against the back or longitudinal wall of the boxes should be an upright deal connected with the wall-plate on the dwarf-wall separating the boxes by means of a mortice and tenon, and receiving in a notch at its top the beam of the roof. The upright deal just mentioned should have a groove formed on its face similar to those previously described on the upright deals at each end of the range at the front of the boxes. Midway in the length of the divisions between the boxes there should be two upright battens opposite to each other at 2½ inches apart, the lower ends of which should be notched into the wall-plate, and the upper ends secured to the tie-beam by a screw-bolt. When the excavations of the boxes are in sound clay and impervious to liquid, all that will be required to be done to the bottom will be to beat it firm; but if the soil be loose and permeable in which the boxes are made, it will be necessary to cover their bottoms with concrete, or perhaps, in some cases, it may be necessary to line them with bricks laid in cement in order to prevent the escape of liquid; and in all cases, before being used, the outside of the dwarf-walls forming the front of the boxes should, from their foundations, be carefully cleared of brick-bats and rubbish let fall by the bricklayers whilst being built, and well puddled. Such precautions are particularly necessary to perfection in the construction of the boxes, as escape of liquid would be great deterioration of the fertilizing quality of the manure—one of the most essential merits of box-feeding consisting in the whole of the liquid being absorbed by the litter, and which, being compressed along with the solid excrement by the trampling of the animals, produces a superiority in quality to that of any manure of a similar description than can be obtained by any other mode.

A simple and very efficient manner of fitting up the cattle-boxes, adopted by Mr. Laycock at Lintz Hall, may here be described as follows, viz.:—The front of the box is furnished with horizontal bars from one pillar to another, their ends fitting rather loosely into the grooves; the lowest is formed of a deal 11 inches wide, with chocks 3½ inches wide fixed on the lower edge near the ends; on the upper edge is hung, by means of hooks formed of flat iron fitting the thickness of the deal, a sheet-iron feeding-pan or manger 2 feet 6 inches in length, 15 inches wide at the top and 8 inches wide at the bottom, 14 inches deep at the back

and 10 inches of perpendicular depth at the front; the hooks are riveted to the backs of the pans near to the ends; on the same deal is a rack, the bars of which are 3-8ths-inch round iron 2 feet 6 inches long, somewhat curved, and each end riveted into a piece of flat iron 1 inch broad and 2 feet 6 inches long, forming a rack about 2 feet high, which is attached to the deal near the lower edge by means of hook-and-eye hinges near the extremities and supported in a sloping position by a piece of small chain at each end, 2 feet long, linked to any desired length to hooks near to the upper edge of the deal. Fig. 1, below, is a section of the manger, and Fig. 2 that of the rack above described, on a scale of 2 feet to an inch.

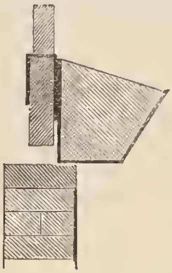


Fig. 1.

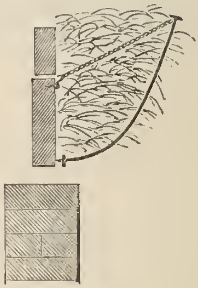


Fig. 2.

Above the deal just described are two other bars formed of Norway battens, the upper one held in its position, about 4 feet above the wall-plate, by means of iron pins or small cotterel-bolts passing through holes in the sides of the grooves and at the ends of the bars. It will be perceived that the racks and mangers can be raised, as the box becomes filled with manure, by placing bars under the deal to which they are attached. The partitions between the boxes are formed of four horizontal bars of battens passing between the two upright battens in the middle of the divisions previously described, with one of their ends fitting into the groove in the pillar at the front, and the other of the ends into that upon the upright deal against the wall at the back of the boxes, each held in its place, about 6 inches apart, by iron pins or small cotterel-bolts passing through holes in the sides of the grooves and at the ends of the battens.

By the above described means of enclosing and separating the boxes, the cattle enjoy the companionship consonant to their natural habits, without the possibility of molesting or injuring each other, producing happiness and quietude, which are circumstances favourable to rapid fattening in all gregarious animals.

Adjoining the boxes to the south, and terminating the range of

buildings under the same roof, is the cow-house (11), 29 feet 8 inches in length, including the south wall, 1½ brick thick, and, including both side-walls, 1½ brick thick each, 20 feet 8 inches in breadth; leaving a length of 28 feet 6 inches, and a breadth of 18 feet 4 inches clear of the walls of the building. Along the north and south walls should be passages 3 feet 6 inches wide having doors at their ends similar to those described for the turnip-house (9), and in the middle of the western wall should be a door in an aperture 4 feet wide. The breadth of the building should be divided into two stalls for holding two beasts each, extending 8 feet from the passages above-mentioned towards the middle of the building, thus leaving a space of 5 feet 6 inches wide between the lower ends of the stalls, affording standings for tying up eight cows,* *i. e.* four with their heads to each passage. The floors of the passages at the heads of the cows should be flagged, or very evenly paved with flat-faced stones, and that of the space in the middle of the cowhouse, behind the cows, may be paved, having a channel of flags about 1 foot wide, covering a drain into which the urine may pass through grates, from thence to be conveyed to the liquid-manure tank (15). The floor of the stalls may be earth beaten firm, and supported by a curb of stone at the top and bottom of the stalls. The stalls, and the fittings for feeding the cattle, need not, in this place, be described; as the construction of a cow-house on a more extensive scale is intended to be specified in a subsequent part of the present essay.

The offices (9, 10, and 11) above described are, all of them, proposed to be under the same roof, which should be hipped at both ends, covered with blue slate finished with stone ridging, and provided, at equal distances from the ends of the ridges and between each other, with cupolas similar to those described when treating of the stable and loose boxes for horses.

The building, marked 12 on the plan, is a single range of twelve cattle-boxes in every respect similar to those described above (10), except in being a single instead of a double range, and therefore requires no observations as to construction. The range of building in question should be to the eastward of that comprising 9, 10, and 11, and separated therefrom by an open passage of 8 feet wide. At the distance of 8 feet to the westward of the range of buildings comprising 9, 10, and 11, is a single range of eight cattle-boxes (13), and the calf-house occupying the space of two boxes, both of which conveniences are under the same roof.

Both ranges of buildings, last noticed, should have span roofs

* The size of the cow-house will admit of holding 10 cows, 5 on each side, instead of 4 mentioned above.

of 3 feet 8 inches pitch, hipped at both ends, covered with blue slate finished with stone-ridging, and each furnished with three cupolas in the length of their ridges.

The passages 8 feet wide between the ranges of buildings, treated of in the present section, may be laid with rubble free-stone on edge to a depth of 8 inches, having the tops of the stones broken level after being laid, and covered with hard stone broken small, or with gravel well rolled; but if a level pavement be not deemed too expensive, it will be found to answer in many respects a better purpose.

Although the whole of the walls of the buildings treated of in the present section have been specified to be of brick, and the pillars supporting the roof in the front of the boxes to be of cast-iron, yet, above the level of the ground, stone may be used for the first mentioned, and timber for the latter mentioned purpose. It may, however, be remarked, that any saving that may be derived from the use of stone and timber, will be fully compensated in the use of brick and iron, not only by neater appearance but by greater durability of the buildings. Many persons may consider that buildings for fattening cattle, erected according to the specification above, as more costly than necessary; but the writer feels assured that any proprietor of an estate desirous of improving his property to the extent that improved construction of farm-buildings can be conducive to that end, and who may have witnessed the result of fattening cattle in properly constructed boxes, would never hesitate to incur the outlay necessary to provide accommodation for carrying out the system to its fullest extent by means of permanent buildings for the purpose.

Liquid-manure Tank (for plan, *vide* Plate I., No. 15).—It is well known that the liquid excrements of animals is, of all matters collected in the farmery, the most valuable for manure: the means for collecting which must therefore be a necessary accommodation in every farmery in which completeness is sought. The site of the tank for liquid-manure in the plan proposed, is marked 15. The receptacle for liquid-manure for a farmery of the size proposed, may be a circular well 20 feet deep and 10 feet in diameter, formed of brick laid in roman cement or tarras, the top formed as a dome with a man-hole in the centre of 2 feet in diameter, in a flag covered close with a plate of cast-iron countersunk in the upper surface of the flag, and a hole for a pump near the side of the well, also covered close with a cast-iron plate fitted into a stone. Behind the brick lining should be well puddled to prevent any escape of the contents of the tank.

Stable-yard (for plan, *vide* Plate I, No. 16). — The space between the front of the range of buildings in which the stable is contained, and the back of that comprising 13 and 14, is 30 feet,

and which, after the surface soil being removed, should be laid with freestone-rubble covered with hard stone, in the same manner as recommended for the passages between the ranges of buildings comprising the cattle-feeding department.

The whole of the buildings should be furnished with spouts at the eaves to receive all the rain-water that may fall on the roofs, to be conveyed by means of wall-pipes, placed conveniently, to underground drains. The spouts and wall-pipes may be of cast-iron, the former 6 inches wide by 4 inches deep, in lengths about 6 feet each, joined by sockets and supported by iron bearings driven into wooden plugs built into the wall for the purpose; the latter should be about 2 inches bore and furnished with cistern-heads.

Estimate of the Cost of erecting the Buildings comprised in the Plan, Plate I., according to the Specification contained in the foregoing sections of the present Essay.

	When the Walls are of Brick.						When the Walls are of Stone.					
	£.	s.	d.	£.	s.	d.	£.	s.	d.	£.	s.	d.
The removal of the surface-soil from the site of the farmery should not be charged in the estimate, inasmuch as the soil is very valuable for forming compost.												
Barn, Straw-Barn, and Granary, to be erected on sites marked 1 and 2 on Plan:—												
Digging foundations, say 40 cubic yards, at 2*d*. per cubic yard	0	6	8		..		0	6	8			
Walls reduced to 1½ brick, or 20 inches thick of stone, the apertures 6 feet and upwards wide deducted, 550 superficial yards at 4*s*. per yard for brick, or 3*s*. per yard for stone	110	0	0		..		82	10	0			
Stone heads and cills for apertures, 1530 feet superficial at 8*d*. per foot . .	6	7	6		..		6	7	6			
Floor of barn, say 60 square yards when the walls are of brick, or 53 square yards when of stone, at 3*s*. per square yard	9	0	0		..		7	19	0			
Floor of straw-barn, including stone cills at the openings	1	10	0		..		1	10	0			
Upper floor of barn and floor of granary, 157 square yards when the walls are of brick, or 146 square yards when the walls are of stone, at 6*s*. 6*d*. per square yard	51	0	6		..		47	9	0			
Pan-pieces for openings, lintels for doors and windows, and wall plates . .	15	0	0		..		15	0	0			
Carried forward . . .	193	4	8		..		161	2	2			

Estimate of the Cost of erecting the Buildings, &c.—*continued.*

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Brought forward . . .	193 4 8	..	161 2 2	
Naked roofing, 193 square yards at 6*s.* 6*d.* per square yard	62 14 6	..	62 14 6	
Slating, including laths, 193 square yards of roofing, at 2*s.* per square yard	19 6 0	..	19 6 0	
128 running feet of stone ridging at 1*s.* 6*d.* per yard	3 4 0	..	3 4 0	
Lead gutter	1 15 0	..	1 15 0	
220 feet of cast iron eaves, spout, and wall pipe, including bearings and fixing, at 9*d.* per foot	8 5 0	..	8 5 0	
4 doors and frames, including hinges and fastenings, at 25*s.* each . . .	5 0 0	..	5 0 0	
5 windows and frames, with close shutters and glazed lights above, for the lower story of barn and straw-barn, including hinges and fastenings, at 15*s.* each	3 15 0	..	3 15 0	
10 windows and frames with latticed shutters, for upper story of barn and the granary, at 12*s.* 6*d.* each . . .	6 5 0	..	6 5 0	
Sliding door for east end of straw-barn	3 0 0	..	3 0 0	
Step-ladder or stairs from the lower to the upper story of barn	3 0 0	..	3 0 0	
		309 9 2		277 6 8
Steam-Engine House and Boiler Shed, to be erected on sites marked 3 and 4 on Plan :—				
The engine is supposed to belong to the tenant; therefore the stone pillar to support the engine, and also the furnace and seat of the boiler, should not be charged in the estimate. The cost of the chimney for the furnace of the boiler has already been estimated in the cost of the building last estimated. The expense of erecting the building in question for the purpose required, so far as it ought to be done by the proprietor of the farm in his capacity as landlord, need not exceed	..	17 0 0	..	15 15 0
The range of Buildings comprising the Stable, loose Horse-Boxes, Dung-Pit, and Implement and Cart-Shed, to be erected on sites marked 5, 6, 7, and 8 on the Plan :—				
Digging foundations, say 45 cubic yards at 2*d.* per cubic yard	0 7 6	..	0 7 6	
Excavating dung-pit, say 50 cubic yards at 2*d.* per cubic yard	0 8 4	..	0 8 4	
Carried forward . . .	0 15 10	326 9 2	0 15 10	293 1 8

Estimate of the Cost of erecting the Buildings, &c.—*continued.*

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Brought forward . . .	0 15 10	326 9 2	0 15 10	293 1 8
Walls reduced to $1\frac{1}{2}$ brick thick, or 20 inches thick of stone, the apertures, 6 feet and upwards wide, deducted, 331 superficial yards of brickwork when walls are of brick, and 306 yards of stone wall, and 25 yards of brick for dung-pit when the walls are of stone, at 4*s.* per superficial yard for brick walls, and 3*s.* for stone walls	66 4 0	..	50 18 0	
Stone heads for 4 doorways, and steps or cills for same, 15 superficial feet at 8*d.* per foot	0 10 0	..	0 10 0	
Moulded cases for 6 circular lights for the stable and horse-boxes, at 7*s.* 6*d.* each	2 5 0	..	2 5 0	
Pan pieces for the dung-pit and implement-shed	5 0 0	..	5 0 0	
Lintels, wall-plates, and cills . . .	8 8 7	..	8 8 7	
110 square yards of flagging for stable and box floors when the walls are of brick, or 100 square yards when of stone, at 2*s.* per square yard . . .	11 0 0	..	10 0 0	
24 yards of brick drain for stable and boxes, with channelled stone covers and grates	3 0 0	..	3 0 0	
Floor for the implement and cart-shed .	0 12 0	..	0 12 0	
280 superficial yards of roofing, at 6*s.* per yard	84 0 0	..	84 0 0	
2 cupolas on ridge for stable and boxes.	2 0 0	..	2 0 0	
Slating, including laths, 280 superficial yards, at 2*s.* per yard	28 0 0	..	28 0 0	
45 running yards of stone ridging at 1*s.* 6*d.* per yard	3 7 6	..	3 7 6	
2 cast iron pillars, on stone plinths, to support pan-piece of implement and cart-shed	1 4 0	..	1 4 0	
Cast iron spouts for eaves, including bearers for same, 252 feet at 9*d.* per foot	9 9 0	..	9 9 0	
7 cast iron stall-posts for stable, at 12*s.* each	4 4 0	..	4 4 0	
7 stalls, formed of red-wood battens, at 25*s.* each	8 15 0	..	8 15 0	
10 iron racks and mangers, and 10 air-grates, at 12*s.* 6*d.* each	6 5 0	..	6 5 0	
6 glazed lights in cast iron circular pivot frames, at 7*s.* 6*d.* each . . .	2 5 0	..	2 5 0	
6 doors and frames, including hinges and fastenings, at 25*s.* each . . .	7 5 0	..	7 5 0	
		254 9 11		238 3 11
Carried forward . . .	..	580 19 1	..	531 5 7

Estimate of the Cost of erecting the Buildings, &c.—*continued.*

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Brought forward . . .	..	580 19 1	..	531 5 7
Range of Buildings comprising Turnip-House, double range of Cattle-Boxes, and Cow-House, to be erected on sites marked 9, 10, and 11 on Plan:—				
Digging foundations, and excavating cattle-boxes, 84 cubic yards, at 2*d.* per cubic yard.	0 14 0	..	0 14 0	
Wall reduced to $1\frac{1}{2}$ brick thick, or when of stone to 20 inches thick, including the chimney for the furnace of steaming apparatus in turnip-house, but deducting apertures 6 feet and upwards wide, containing 295 superficial yards of brick, or 200 yards stone and 95 yards brick for boxes when the walls are of stone, at 4*s.* per yard for brickwork and 3*s.* for stone	59 0 0	..	49 0 0	
Floor of turnip-house 56 square yards, at 2*s.* per square yard.	5 12 0	..	5 12 0	
21 square yards of flag for cow-house, at 2*s.* per square yard.	2 2 0	..	2 2 0	
13 yards of drain and channel cover, with grates at the bottom of cow-stalls, at 2*s.* per lineal yard . . .	1 6 0	..	1 6 0	
24 yards of stone curb for cow-stalls, at 1*s.* per lineal yard.	1 4 0	..	1 4 0	
Wall-plates, lintels, and pan-pieces . .	11 13 4	..	11 13 4	
10 cast iron pillars, supporting roof in front of boxes, and fixing same, at 12*s.* each	6 0 0			
If supports are of timber, at 5*s.* each .	..	..	2 10 0	
10 jambs for the backs of the boxes, and 4 for the ends of the range at the fronts, with grooves formed of half-width of batten on face	3 10 0	..	3 10 0	
10 double uprights of batten from wall-plates of division between the boxes to the tiebeams of the roof	1 15 0	..	1 15 0	
330 square yards of roofing at 6*s.* 6*d.* per square yard	107 5 0	..	107 5 0	
3 cupolas in the ridge	3 0 0	..	3 0 0	
Slating, including laths, 330 square yards, at 2*s.* per square yard . . .	33 0 0	..	33 0 0	
52 yards of stone ridging, at 1*s.* 6*d.* per yard	3 18 0	..	3 18 0	
Cast iron spouts for eaves, including bearers	10 15 3	..	10 15 3	
Sliding-door at north end of turnip-house, with fittings complete . . .	3 5 0	..	3 5 0	
Carried forward . . .	253 19 7	580 19 1	210 9 7	531 5 7

Estimate of the Cost of erecting the Buildings, &c.—*continued.*

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Brought forward . . .	253 19 7	580 19 1	240 9 7	531 5 7
7 doors and frames in turnip-house and cow-house, including hinges and fastenings, at 20*s.* each	7 0 0	..	7 0 0	
Cow-stalls	4 0 0	..	4 0 0	
		264 19 7		251 9 7
N.B.—The bars forming the front fence of, and the divisions between, the boxes, and also the feeding mangers and racks described and recommended in a preceding page, being movable are supposed to belong to the tenant in his capacity as such · the troughs or mangers in the cow-house are also supposed to belong to the tenant, and are therefore not charged in the estimate.				
Single range of Cattle-Boxes to be erected on the site marked 12 on the plan:—				
Excavating boxes	1 6 8	..	1 6 8	
175 superficial yards of brick wall, or 110 yards of stone wall, and 65 of brick for the boxes when the buildings are of stone, at 4*s.* per yard for brickwork, and 3*s.* for stone . . .	35 0 0	..	29 10 0	
Wall-plates, &c.	10 5 0	..	10 5 0	
11 cast iron pillars supporting roof in front, and fixing same, at 12*s.* each .	6 12 0			
If supports are of timber, at 5*s.* each .	..	..	2 15 0	
11 jambs for the backs of the boxes, and 2 for the ends of the range in front .	3 5 0	..	3 5 0	
11 double uprights	1 18 6	..	1 18 6	
180 square yards of roof, at 6*s.* per square yard	54 0 0	..	54 0 0	
3 cupolas.	3 0 0	..	3 0 0	
Slating, including laths, for 180 square yards of roof, at 2*s.* per square yard .	18 0 0	..	18 0 0	
47 yards of stone ridging, at 1*s.* 6*d.* per yard	3 10 6	..	3 10 6	
Cast iron spouts for eaves, including bearers	9 15 0	..	9 15 0	
		146 12 8		137 5 8
Range of Building comprising 8 Cattle-Boxes and Calf-House, to be erected on sites 13 and 14 on Plan:—				
The construction of these offices being precisely similar to those last estimated, their estimate may be taken in proportion at	..	125 0 0	..	113 0 0
Carried forward . . .	..	1117 11 4	..	1033 0 10

Estimate of the Cost of erecting the Buildings, &c.—*continued.*

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Brought forward . . .	..	1117 11 4	..	1033 0 10
The passages between the ranges of Buildings comprising the feeding department to be evenly paved; 212 yards at 1*s.* 6*d.* per yard	..	15 18 0	..	15 18 0
The Liquid Manure Tank, the position of which is 15 on the Plan:—				
Sinking a well, 12 feet in diameter and 20 feet deep, at 2*s.* per foot in depth .	2 0 0	..	2 0 0	
Forming tank of brick laid in cement, 10 feet inside diameter, and the back puddled with clay	24 0 0	..	24 0 0	
Stone cases for man-hole and pump-hole	0 17 6	..	0 17 6	
Cast iron covers for holes	0 7 6	..	0 7 6	
		27 5 0		27 5 0
60 feet of earthenware socket drain-tube, for conveying urine from stable and cow-house to tank, at 4*d.* per foot .	1 0 0	..	1 0 0	
Laying same	0 2 6	..	0 2 6	
		1 2 6		1 2 6
Levelling and laying yard with broken stone, 400 square yards, at 3*d.* per square yard	..	5 0 0	..	5 0 0
Total	..	1166 16 10	..	1082 6 4

The foregoing estimate referable to a farmery designed in Plates I. and II., amounting to 1166*l.* 16*s.* 10*d.*, when the walls are of brick,* and to 1082*l.* 6*s.* 4*d.* when built of stone, is intended to include the cost of materials and workmanship but not that of carriage; and although the charge of some of the items may appear to be very low, yet the writer has seen work executed by contract in every way suitable to the purpose of a farmery at less cost than the rates on which the foregoing estimate is based; and where the materials can be obtained at a moderate price, he is convinced that contractors may be found to build a set of farm buildings on the plan, and to the same extent, as that proposed within the amount named.

The buildings to which the estimate and foregoing remarks apply, it will be perceived, are such as would be required on a tillage farm, and in which accommodation is principally provided with a view to winter fattening of cattle on an extensive scale: but it very frequently occurs that the extensive tillage farmer has

* Since this estimate was made the duty on bricks has been repealed, by which the cost of brick buildings will be so reduced as not to exceed that of stone buildings.

a taste for the breeding of cattle at the same time that his attention is directed to preparing them for the shambles, or perhaps a portion of the farm may be well adapted for the dairy; in either of which cases the accommodation proposed may be insufficient for either purpose, whilst it may be unnecessarily extensive in other respects where a farm of the size to which it is intended to be applied may not be wholly in tillage. In order then to render the present Essay the more comprehensive in its application, a plan is about to be treated of, the arrangement of the buildings in which has already been referred to in a former page. The plan about to require attention may be adopted to any extent commensurate with the quantity of land that may be in the mode of cultivation to which the buildings about to be treated of are adapted, in conjunction with so much of the former described plan as may be required for the proportion of land in tillage.

The intention of the arrangement of the plan in Plate III. if for a dairy will be easily understood. The whole of the offices required in that branch of rural economy are placed together, in order to economise the labour of the business to the greatest extent; and the dairy itself, the business of which being usually under the superintendence of the farmer's wife, is designed to adjoin, and have communication with the dwelling-house. The accommodation is also perhaps as complete, and the arrangement as convenient with a view to the breeding of cattle, as it is for the purposes of the dairy.

Without further introduction to the subject, the dimensions and construction of the buildings comprised in the plan in Plate III. will now be treated of.

Of the Fodder-house (for plan, *vide* Plate III., No. 1).—The apartment marked 1 on the plan is intended for a fodder-house, and occupies a space including walls of 17 feet long by 14 feet wide. The walls are intended to be $1\frac{1}{2}$ brick thick, or of 20 inches if built of stone, except the wall separating it from the bull-boxes (11), which need not exceed 1 brick in thickness, and their height is designed to be 7 feet, having apertures for doors 3 feet 6 inches wide in the south and west walls, communicating with the calf-house (8) and with the shed (2), and an opening in the east wall, 8 feet wide, for a sliding-door. The floor may be of freestone chips or rubble covered with any hard stone broken small. As the roof covers adjoining apartments as well, it will be noticed at a future opportunity.

Of the Boiler-shed (for plan, *vide* Plate III., No. 2).—Adjoining the office last described, and communicating with it, is a shed 25 feet long (the width of the open yard, 14), and 10 feet wide, communicating at the south-west corner with the south feeding passage of the cow-house (3) by an aperture, for a door,

4 feet wide. In the back wall of this shed, at its mid length, a flue should be provided for the furnace of a steaming apparatus. The roof may fall to the back wall, which should be 9 feet high, decline to the front at 7 feet from the ground, and carried upon a deal supporter by two cast-iron pillars upon stone plinths. The floor should be flagged—at any rate about the steaming apparatus.

Of the Cow-house (for plan, *vide* Plate III., No. 3).—The best mode of internal arrangement for a cow-house, where many cows are kept, is for the stalls to be in two ranges parallel to the side walls of the building, having a passage along each of the side walls at the heads of the cattle for the purpose of conveniently supplying them with provender, and another passage between the ranges of stalls from which the cows may be milked, and the dung removed. In some cow-houses of modern erection, the heads of the ranges of stalls are placed opposite to each other along the sides of a passage extending along the middle of the building, and the dung from the cows removed from passages between the bottoms of the stalls and the side walls. Whatever may be gained in decrease of labour in feeding the cows by means of the latter described mode of arrangement, is more than compensated by greater wholesomeness in the cattle being less subject to be breathed upon by each other, and by the less labour required in removal of the dung by the adoption of the former described manner of disposing the stalls.

The proper size of stalls, to contain two cows in each, is 8 feet square. The building proposed in the plan referred to for the cow-house, is 40 feet long and 32 feet wide, exclusive of the thickness of the walls; which dimensions, by allowing a passage of 4 feet wide at the head of the stalls 8 feet deep, with a space 8 feet wide along the middle of the building between the two ranges of stalls, and the length of the building being equally divided into five stalls, will provide standings for twenty cows. Buildings having lean-to roofs being intended, according to the plan proposed, to adjoin the cow-house, and be separated from it by its side walls, the walls of the cow-house should not be less than 10 ft. high above the surface of the ground, and when built of brick, 1½ brick thick, or, if of stone, 20 inches thick. The apertures in this building are, one at the east end of each of the feeding passages 4 feet wide for doors, and one in the middle of the same walk, 8 feet wide, for a door opening into halves of its breadth as an entrance to the passage between the ranges of stalls; one in the west wall, 4 feet wide for a door communicating with the scalding-room (4); and one in the south wall, 3 feet 6 inches wide, communicating with the calf-house (8). All the openings above mentioned should be 7 feet high, and furnished with doors and frames of the same construction as specified on a previous

occasion; and the openings at the east end to be furnished with dressed stone-heads 12 inches deep. Near the western extremities of the north and south walls should be openings 3 feet square with stone heads and sills, for windows to be furnished with sliding-bar shutters. The floors of the passages at the heads of the stalls should be flagged, and that of the spaces between the ranges of stalls evenly paved, with brick drains along each side at the bottoms of the stalls and covered with channelled stone furnished with grates. The floors of the stalls may be earth beaten firm, should be about 8 inches above the channels at the bottoms of the stalls, and supported by curbs of stone. Between each stall at top and bottom should be a pillar of Norway timber 6 inches square supporting longitudinal beams of the same scantling, on which the tie-beams of the principal rafters or couples of the roof, placed directly above the divisions of the stalls, may rest; and into the upright pillars the divisions of the stalls, formed of Norway battens constructed in the same manner as recommended for the divisions of the stalls of the stable, but of less height by a foot both at top and bottom, may be framed. The roof may have a pitch of 8 feet, and be of Norway battens, the couples having a crown post and struts; and the small rafters and purlines, in consequence of the greater span of the roof, should be one-half instead of one-third the breadth of batten recommended for the buildings previously described. Oxen generally, and especially cows, are liable to pulmonary diseases of a most malignant character, very frequently produced or much aggravated by, impurity of the atmosphere of the places in which they are confined. In order to obtain a free circulation of fresh air in the cow-house proposed, it is suggested that there be three glazed lights in cast-iron pivot frames 3 feet square in the roof above the side passages, at equal distances from the ends of the building, and between each other; and also that there be in the ridge at the mid-length of the building, a cupola, at least 4 feet square, of the same construction as those previously recommended for the stables and cattle-boxes.

For mangers for the cow-house, as well as for the stable, nothing can be more suitable for the purpose than cast-iron; and as moveable troughs 2 feet 6 inches long, 1 foot 6 inches wide, and 1 foot deep, may be conveniently used, and which may belong to the tenant, such fittings do not require notice as permanent accommodation to be provided by the proprietor of a farm.

Of the Dairy (for plan, *vide* Plate III., Nos. 4, 5, 6, and 7).—The business of the dairy being usually under the superintendance of the mistress of the farm-house, the offices required for that branch of rural economy should either be a portion of, or be

immediately adjacent to, the dwelling-house. In the plan referred to, the offices for keeping and preparing the milk after it has been taken from the cow, consists of a range of apartments adjoining to, and having communication with the dwelling-house from the south end; also adjoining to, and having communication with the cow-house from the east side; and is under the roof covering the last-mentioned office of the farmery.

The apartments comprising the dairy proposed are the scalding-room (4), 15 feet long by 12 feet wide, communicating with the dwelling-house, and also with the cow-house, into the space between the ranges of stalls of which, by a descent of two steps, should be lighted by a window in the west wall, and fitted with a boiler in the south-east angle; the churning-room (5), 12 feet square, having a door and window in the west wall; the milk-house (6), 10 feet long by 12 wide, having a window in the north wall; and a shed (7), in which to expose the milk vessels and utensils after having been scalded to drain and sweeten in the air, to be the length of the three apartments previously noticed, and 6 feet wide, covered by a continuation of the west slope of the roof of the cow-house and dairy, and which is proposed to be supported in front by four cast-iron pillars. The three apartments comprising the dairy should be 9 feet in height, having flagged floors 1 foot above that of the middle passage of the cow-house, and the division walls between them one brick thick, with doors of communication between each other. The walls of the dairy apartments should be plastered, and their tops ceiled; and the milk-house should be furnished with shelves, for which purpose no material can be better than slate.

Of the Calf-house (for plan, *vide* Plate III., No. 8).—The subject about to be treated of in the present section, according to the plan proposed, adjoins part of the cow-house (3), the shed (2), and the fodder-house (1), on the south, having doors of communication from the cow-house and from the fodder-house; and it extends, including the end walls, each $1\frac{1}{2}$ brick thick, 62 feet 4 inches in length, and including the front wall, 1 brick thick, is 10 feet in breadth. The front wall is proposed to be 6 feet high, with a roof leaning to the south wall of the cow-house and shed, and also to the south end wall of the fodder-house, carried up to 10 feet high, at 9 feet from the ground, or 1 foot below the south eave of the cow-house, from the water tabling on the top of the south wall of the shed, and on the top of the wall carried up at the south end of the fodder-house. This office may be lighted and ventilated by means of three glazed lights in cast-iron pivot frames near the highest part of the roof. The floor should be evenly paved, well drained from moisture, and fitted with pens

for a single calf in each, which, however, does not require any minute description.

Of the Pigsties and Poultry-houses (for plan, *vide* Plate III., Nos. 9 and 10).—Swine and poultry, the minor description of farm stock, are usually objects of less attention by farmers than their importance in the economy of farming deserves—being generally considered as mere save-alls in the farmery, and as such left to pick up a subsistence on what grain and other matters, which, were it not by their being kept, would be utterly wasted. Although it is not intended in the proposed plan to provide the accommodation of the extensive poultry establishments of the wealthy, or in the present essay to recommend that the tenant farmer should keep a greater number of swine than requisite to consume every article of offal on the farm that might otherwise be lost, to profitable account, or properly attended to without having to employ servants for the express purpose; yet, on the principle of every gain, however small, being a substantive ingredient of the aggregate profit derived from capital, it is necessary to have, in every farmery, such accommodation, that every branch of the farmer's business, however minute in profitable return, may be carried on with the greatest degree of economy: so accommodation for keeping swine and poultry, to the extent above mentioned, should be provided in every farmery having pretension to completeness.

The care of the swine usually devolving on those having care of the cows, and that of the poultry on the dairy-maid, or some servant employed in the duties of the household, and, moreover, a considerable portion of the food of sows, young pigs, and fattening hogs, being derived from the dairy, the position of the accommodation referred to will be properly in the neighbourhood of both the cow-house and dwelling-house.

In the proposed plan the accommodation for keeping swine and poultry consists of a range of buildings leaning to the north wall of the cow-house, 34 feet 4 inches in length, including all walls, and 6 feet 9 inches in breadth, including the thickness of the front wall, which should be 7 feet high, with the roof sloping to 1 foot below the eave of the cow-house. A portion of the range (9), 7 feet long by 6 feet wide, may be appropriated as a roost for geese or ducks; and the remainder may have two stories, the lower of which, 4 feet high, and divided into five compartments, may be used as sties for sows and fattening hogs; and the upper for poultry that roost or perch. In front of the lower story there should be a small court, 5 feet wide, enclosed by either walls or paling; and the upper story should be furnished with a light in the roof, and with as large a door at the east end as the height of

the wall will admit of. The floors of the goose or duck house, and the pigsty with its court in front, should be flagged; and the pigsty furnished with a drain to convey all wetness to a liquid manure tank.

Of the Bull Boxes (for plan, *vide* Plate III., No. 11).—Adjoining the fodder-house (1), and under the same roof with it, are three boxes for bulls which are each marked in the plan with 11. The boxes in question may be constructed in every respect in the manner already described, in treating of the boxes referred to in Plate I., and the only difference to notice between them is in their dimensions, which in the present instance is recommended to be 12 feet by 9 feet in the clear, instead of 9 feet square as specified for those for fattening cattle.

Of the Dung-pit (for plan, *vide* Plate III., No. 12).—As a receptacle of dung from the cow-house, calf-house, and pigsties, a pit lined with brick 24 feet long, 8 feet wide, and 5 feet deep, may be formed at the east end of the cow-house in the position marked 12 on the plan, and which may be covered with a stout wooden lid supported by transoms.

Of the Liquid Manure Tank (for plan, *vide* Plate III., No. 13).—The position of the receptacle for liquid manure is under the shed (2), and its dimensions and construction may be in every respect similar to that previously described in treating of the accommodations proposed in the plan on Plate I.

Yard (for plan, *vide* Plate III., No. 14).—The space between the cow-house, and the bull-boxes and fodder-house, is proposed to be 25 feet wide, and the space between the buildings comprised in the plan now referred to, and such portion of the buildings comprised in the plan in Plate I., that may be required for the system of husbandry practised on the farm, should be 30 feet wide, and both may be laid with freestone rubble, covered with hard stone, broken small, as directed for the yard proposed in Plate I., No. 16.

The whole of the roofs of the buildings proposed in the plan referred to are recommended to be covered with blue slate, finished with stone ridging, and the eaves to be furnished with cast-iron spouts and wall pipes to carry off the rain-water falling on the roofs.

Estimate of the Cost of erecting the Buildings comprised in the Plan, Plate III., according to the Specifications contained in the foregoing Sections of the present Essay.

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
The removal of the surface soil from the site of the farmery should not be charged in the estimate of the cost of buildings, as the soil is very valuable for forming composts, and should always be applied to that purpose.				
Fodder-House and Bull Boxes to be erected on Sites marked 1 and 11 on the Plan :—				
Excavation for boxes and digging foundations of fodder-house, say 48 cubic yards, at 2*d.* per cubic yard . . .	0 8 0	. .	0 8 0	
Walls, reduced to 1½ brick thick, or when of stone to 20 inches thick, deducting apertures 6 feet wide and upwards, containing 103 superficial yards of brickwork when the walls are of brick, or 85 superficial yards of stone work, and 18 superficial yards when the walls are of stone, at 4*s.* per yard for brick, and 3*s.* per yard for stone	20 15 0	. .	16 10 0	
Wall plates, lintels, &c.	5 18 0	. .	5 18 0	
2 cast-iron pillars, supporting roof of boxes in front and fixing, at 12*s.* each	1 4 0	. .		
If supports are of timber at 5*s.* each .	. .	. .	0 10 0	
3 jambs for the backs of the boxes, and 2 for the ends at front of range . .	1 5 0	. .	1 5 0	
3 double uprights of batten from wall plates of divisions between the boxes and tiebeams of roof	0 10 6	. .	0 10 6	
85 square yards of naked roofing, at 6*s.* per square yard	25 10 0	. .	25 10 0	
Slating, including laths, 85 square yards, at 2*s.* per square yard	8 10 0	. .	8 10 0	
24 yards of stone ridging, at 1*s.* 6*d.* per yard	1 16 0	. .	1 16 0	
Cast-iron spouting for eaves, including bearers and wall pipes	3 19 6	. .	3 19 6	
Lead gutter at south end of fodder-house	1 15 0	. .	1 15 0	
Sliding-door in fodder-house complete .	3 5 0	. .	3 5 0	
2 doors and frames in fodder-house, with hinges and fastenings, at 25*s.* each .	2 10 0	. .	2 10 0	
Floor of fodder-house	0 5 0	. .	0 5 0	
		77 11 0		72 12 0
Shed for Steaming Apparatus, to be erected on site No. 2 on the Plan :—				
Digging foundation for wall . . .	0 1 0	. .	0 1 0	
Carried forward . . .	0 1 0	77 11 0	0 1 0	72 12 0

Estimate of the Cost of erecting the Buildings, &c.—*continued.*

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Brought forward . . .	0 1 0	77 11 0	0 1 0	72 12 0
Walls, including chimney of furnace for steam apparatus, 40 superficial yards, at 4*s.* per yard if brick, or 3*s.* per yard if stone	8 0 0	..	6 0 0	
Deal to carry front of roof	0 15 4	..	0 15 4	
2 cast-iron pillars to support front of roof, and fixing, at 12*s.* each . . .	1 4 0	..	1 4 0	
Stone coping for wall	0 12 6	..	0 12 6	
Roofing and slating	11 5 0	..	11 5 0	
Flagging for floor	2 16 0	..	2 16 0	
		24 13 10		22 13 10
Cow-House and Dairy to be erected on Sites Nos. 3, 4, 5, and 6 on the Plan :—				
Digging foundations	0 6 0	..	0 6 0	
Walls, reduced to 1½ brick thick of brick, or 20 inches of stone, deducting for openings 6 feet and upwards wide, containing 284 superficial yards, at 4*s.* per yard if of brick, or 3*s.* per yard if of stone	56 16 0	..	42 12 0	
Wall plates, pan piece for door, 8 feet wide, and lintels	9 0 0	..	9 0 0	
240 square yards of naked roofing, at 7*s.* 6*d.* per square yard	90 0 0	..	90 0 0	
Slating, including laths, 240 square yards of roofing, at 2*s.* per square yard	24 0 0	..	24 0 0	
40 yards stone ridging, at 1*s.* 6*d.* . .	3 0 0	..	3 0 0	
Dressed stone heads for 3 doors, and steps for same	1 0 0	..	1 0 0	
Dressed stone heads, and sills for 5 windows	1 13 4	..	1 13 4	
6 cast-iron glazed skylights in roof of cow-house, at 15*s.* each	4 10 0	..	4 10 0	
2 window-frames in cow-house, with slide-bar shutters, at 12*s.* 6*d.* each .	1 5 0	..	1 5 0	
Cupola in ridge of cow-house . . .	3 0 0	..	3 0 0	
Lead gutter	1 16 0	..	1 16 0	
Cast-iron spouts, including bearers . .	2 13 0	..	2 13 0	
Floor of side passages of cow-house, 37 yards of flagging, at 2*s.* per square yard	3 14 0	..	3 14 0	
Floor of passage between ranges of stalls of cow-house, 27 square yards of paving, at 1*s.* 6*d.* per square yard .	2 0 6	..	2 0 6	
30 yards of drain in cow-house, with channelled cover and grates, at 2*s.* per lineal yard	3 0 0	..	3 0 0	
Stone curbs at the top and bottoms of stalls of cow-house	4 1 0	..	4 1 0	
Carried forward . . .	211 14 10	102 4 10	197 10 10	95 5 10

Estimate of the Cost of erecting the Buildings, &c.—*continued.*

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Brought forward . . .	211 14 10	102 4 10	197 10 10	95 5 10
Floor of dairy, 50 square yards of dressed flagging, at 3*s.* per square yard . .	7 10 0	. .	7 10 0	
2 stone steps from dairy to cow-house .	0 6 8	. .	0 6 8	
Plastering walls and ceilings of dairy .	5 0 0	. .	5 0 0	
Shelves for milk-house and fixing . .	7 12 0	. .	7 12 0	
Stall posts, beams, and stalls for cow-house	6 8 0	. .	6 8 0	
7 doors and frames, including hinges and fastenings, at 25*s.* each . . .	8 15 0	. .	8 15 0	
Pair of folding-doors for east end of cow-house, including hinges and fastenings	2 10 0	. .	2 10 0	
3 glazed windows for dairy, including shutters and fastenings	5 0 0	. .	5 0 0	
Levelling and forming floors of stalls in cow-house	0 10 0	. .	0 10 0	
		255 6 6		241 2 6
Shed to be erected on the site No. 7 on the Plan :—				
Wall	1 8 0	. .	1 1 0	
4 cast-iron pillars, and fixing, at 12*s.* each	2 8 0	. .	2 8 0	
Deal, carrying the roof at front . . .	1 6 8	. .	1 6 8	
Roof, including slating, 29 yards, at 7*s.* 6*d.*	10 17 6	. .	10 17 6	
6½ feet of water tabling, at 6*d.* per foot	0 3 3	. .	0 3 3	
Lead flashing at wall of dwelling-house	0 7 6	. .	0 7 6	
Cast-iron spouts, including bearers . .	1 17 6	. .	1 17 6	
Flagging, 27 square yards, at 2*s.* per yard	2 14 0	. .	2 14 0	
		21 2 5		20 15 5
Calf-House, to be erected on site No. 8 on the Plan :—				
Walls, including carrying up the south end wall of the fodder-house, stone coping on top of same, and digging foundations	12 0 0	. .	9 2 0	
Lean-to roof, including slating . . .	26 5 0	. .	26 5 0	
7 yards of water tabling	0 10 6	. .	0 10 6	
3 glazed lights in cast-iron swing frames	1 10 0	. .	1 10 0	
Cast-iron spouts, including bearers . .	3 2 3	. .	3 2 3	
Floor, flagged, 60 yards, at 2*s.* . . .	6 0 0	. .	6 0 0	
24 yards of drain, with channelled stone cover and grates	2 8 0	. .	2 8 0	
		51 15 9		48 17 9
N.B.—The calf-pens may be moveable, and belong to the tenant.				
Pigsties and poultry roosts to be erected on sites Nos. 9 and 10 on the Plan :—				
Walls, including fences, pig-sties, and digging foundations	9 14 0	. .	7 6 0	
Carried forward . . .	9 14 0	430 9 6	7 6 0	406 1 6

Estimate of the Cost of erecting the Buildings, &c.—*continued.*

	When the Walls are of Brick.		When the Walls are of Stone.	
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Brought forward . . .	9 14 0	130 9 6	7 6 0	406 1 6
Stone heads for openings into pigsties .	0 12 6	..	0 12 6	
Floors of flags, 35 square yards, at 2*s*. .	3 10 0	..	3 10 0	
Drain and grates	1 4 0	..	1 4 0	
Floor of poultry-house above pig-sties, 15½ square yards, at 4*s*.	3 2 0	..	3 2 0	
Perches for poultry-house	0 4 0	..	0 4 0	
Lean-to roof, including slating, 27 square yards, at 7*s*. 6*d*.	10 2 6	..	10 2 6	
14 feet of water tabling	0 7 0	..	0 7 0	
Cast-iron spouts, including bearers . .	1 14 6	..	1 14 6	
2 doors and frames for poultry-houses, at 17*s*. 6*d*. each	1 15 0	..	1 15 0	
3 lights in cast-iron swing frames . .	1 10 0	..	1 10 0	
5 wickets and pairs of posts for pigsties	3 2 6	..	3 2 6	
		36 18 0		34 10 0
Dung-pit to be formed in the position marked No. 12 on the Plan :—				
Excavating 54 cubic yards, at 3*d*. per yard	0 13 6	..	0 13 6	
Lining with brick 1 brick thick . .	7 0 0	..	7 0 0	
Cover formed of battens, supported by 4 transoms, 6 inches square . . .	7 2 6	..	7 2 6	
		14 16 0		14 16 0
Liquid Manure Tank, No. 13 on the Plan, being of the same size and construction as that in Plan in Plate I., may be estimated at the same cost, viz. :—	27 5 0	..	27 5 0	
Yard No. 14 on the Plan,—estimate for levelling and laying the same with broken stone—112 square yards, at 3*d*. per square yard	1 8 0	..	1 8 0	
And also 150 square yards of yard between dairy and tillage offices at the same price	1 17 6	30 10 6	1 17 6	30 10 6
Total	..	512 14 0*	..	485 18 0

Although designs, specifications, and estimates for the erection of the buildings required in both the tillage and the dairy, or breeding departments, have been referred to and given in the present Essay, yet an indispensable accommodation of the farmery for a branch of husbandry very frequently practised still remains to be noticed.

It is a well ascertained fact that young cattle, from the time of their being weaned until they have nearly or quite completed the second year of their age, require freedom and exercise to attain the necessary growth of frame to fatten at an after period to the

* Since the repeal of the duty on bricks this estimate may be reduced to 486*l*. 12*s*.

greatest advantage; and that to confine and attempt to fatten oxen by forced feeding, previous to their having nearly attained full growth, is apt to stop the development of frame required to carry a great thickness of flesh, if such treatment should not be, as it frequently is, productive of absolute disease, from the shock the constitution of the animals sustains by so violent an opposition to nature. The aim of the prudent rearer is to promote in his stocks a continually progressive increase of frame and muscle, without acquiring fat: to attain which object in the animals requires a plentiful supply at all times of provender of good (but not of too nutritive) quality, considerable extent of freedom, and, in winter, perfect (but not in any degree heating) shelter. These circumstances will be best fulfilled during winter by means of fold-yards provided with sheds: the position, size, and construction of which accommodation of the farmery will be the subject of the following section of the present treatise.

Of Folds and Sheds (for plan, elevation, and section, *vide* Plate VI.).—The position of folds and sheds should be as near as can be to that part of the farmery from whence provender and litter is supplied, having at the same time a full exposure, if possible, to the south. In the plan proposed in Plate VI. this accommodation is placed at the north-east corner of the straw-barn, and ranges eastward, having the stack-yard to the north. As to size of site, 24 feet wide by 18 feet deep for an open fold, in addition to a shed of the same breadth by 12 feet deep, will be sufficient to contain five growing oxen; and in the plan referred to, four compartments of the size mentioned comprise the proposed extent of the accommodation now under consideration. The bottom, or floor of the fold-yard, should be sunk about 1 foot below the surface of the surrounding ground, and also that of the floor of the shed, which should be supported by a stone curb in the front. The shed should have its back and end walls 7 feet high above the surface of its floor, should have a hipped span-roof carried in front by a deal, which may be supported either by cast-iron or timber pillars at every 8 feet of the length of front. The fences of the ends of the range of folds should be walls of the same height as those forming the ends of the range of sheds, and that of the front may either be a wall 5 feet high above the surface of the ground outside, having gate-ways 8 feet wide in the centre of each compartment of the breadth of 24 feet above mentioned; or, what is much better, three bars of battens, the highest of which 5 feet above the ground outside, with their ends held in grooves on cast-iron posts, fixed on a maintaining wall 1 foot high above the bottom of the fold, in a similar manner to that recommended for the boxes. The divisions of the compartments will be best of bars of battens, the ends of which held

in grooves in the cast-iron posts in front, or by a jamb of deal against the wall, when such may be the fence in front, into grooves on cast-iron posts fixed on plugged stones sunk 18 inches below the surface of the floor of the fold at its mid-depth, into grooves on the posts in the front of the shed, on cast-iron posts fixed on plugged stones sunk 18 inches below the floor of the shed at the middle of its depth; and lastly, into grooves on jambs of deal against the back wall of the shed. When the last described mode of fencing the fronts of the folds is adopted, there must be a gap left in the maintaining wall for a paved and inclined cart-way, 8 feet wide, into each compartment. The roof should be covered with blue slate, finished with stone ridging, and have cast-iron spouts at the eaves.

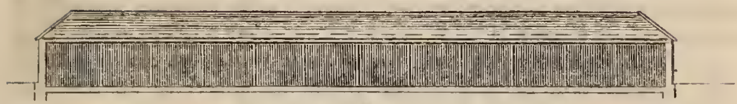
Estimate of the Cost of Folds and Sheds proposed in the Plan, Plate VI., according to the Specification contained in the foregoing section.

	Walls of Brick.			Walls of Stone.		
	£.	s.	d.	£.	s.	d.
Excavating fold-yard and digging foundations for walls	0	15	0	0	15	0
Walls, exclusive of front fence of fold	32	0	0	23	17	0
Wall-fence in front of fold, including 4 pairs of stone gate posts	5	0	0	3	15	0
If cast-iron pillars, as described in the specification, are adopted, it will increase the last charge by . .	3	12	0			
Stone curb for supporting floor of the shed	1	0	0	1	0	0
11 cast-iron pillars supporting front of roof of shed, and fixing, at 12*s.* each	6	12	0			
If the supports are of timber		..		2	15	0
6 cast-iron posts for divisions between the compartments, including stone blocks and fixing . . .	4	10	0	4	10	0
4 jambs against back wall of shed	1	0	0	1	0	0
Wall-plates and deal to carry roof in front . . .	6	14	0	6	14	0
155 square yards of roofing, including slating, at 8*s.* per square yard	62	0	0	62	0	0
Stone ridging	2	18	6	2	18	6
Cast-iron spouts, including bearers and fixing . . .	5	9	6	5	9	6
Total . . . . £	131	11	0*	114	14	0

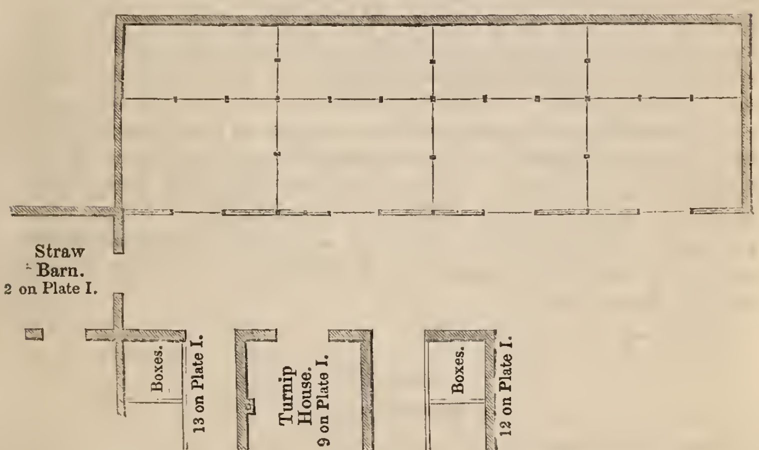
Conclusion.—Stating the size of a farm only is not a sufficient *datum* on which to design a set of farm-buildings. The quality of the soil and the system of husbandry intended to be pursued are also necessary to be known before a judgment can be formed of the kind and extent of accommodation in buildings to be provided. In order to meet the requirements of almost any system of husbandry that may be adopted on a farm of the size stated in

* By the repeal of the duty on bricks this amount will be reduced to 123*l.* 8*s.*

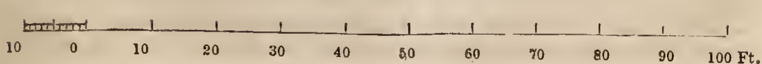
Plate VI.



ELEVATION OF SHED.



SECTION.



the *thesis* on the subject of farm-buildings proposed by the Royal Agricultural Society of England, the buildings necessary for each of several modes of occupation of land—tillage, combined with winter fattening of oxen—dairy or breeding—and the rearing of young cattle—have been treated of separately in the foregoing pages, and distinct plans for each branch of husbandry have been referred to in Plates I., III., and VI., so that a proprietor of an estate contemplating the erection of farm-buildings may combine such a proportion of any of the plans proposed as to suit the circumstances of the size, the quality of soil, and the system of husbandry to be pursued, that any farm may require on which it is intended to build.

From the separate estimates given in the present treatise, it may perhaps be inferred that a set of new buildings, suitable for a farm of 300 acres, under a mixed system of husbandry that prevails in many parts of the United Kingdom, may be substantially built according to the principles of arrangement and specification of building recommended in this Essay, at a cost varying from 1200*l.* to 1500*l.*, exclusive of the carriage of materials, according to the proportionate extent in which the different branches of husbandry above mentioned may form a part of the business of the farm. It may also be remarked that, where buildings are previously in being, the materials of them, when properly applied in the erection of new ones, may considerably reduce the amount of estimate, and much expense of carriage also may be thereby saved.

Newcastle-upon-Tyne, February, 1849.

Appendix A.

It may sometimes happen that a tenant farmer may wish to have increase in the accommodation in his farm-buildings, and that his landlord may either not be in a position, or may be unwilling to comply with such desire. In such a case it cannot be expected, how much soever it may be to his interest, that any tenant, as the law at present stands with regard to improved buildings by tenants, would erect expensive permanent buildings at his own expense; but many tenants might be willing to incur a comparatively small cost in increasing the accommodation of his farmstead, if his purpose was likely to be answered thereby. To such readers as may be circumstanced as above-mentioned, the following extract from a paper on cattle-sheds and folds in the second volume of the 'Plough' is recommended to their notice:—

"Suppose a range of sheds to be commenced at the angle or corner of a fold-yard, and ranged along one side of it; let the wall or fence of this side be carried up to 9 feet, if not already that height, with rubble walling sufficient to keep out the wind; this will serve for the back, and a wall at a right angle forming the corner will answer for a side of the intended range of sheds. Let rough posts, 5 inches diameter at the smaller ends, ranged in a straight line parallel to, and 12 feet distance from, the back

wall, and at 12 feet distance from each other, be sunk 1½ or 2 feet into the ground, and rising 6 feet above the surface; the part underground, and for 6 inches above, should be well charred to prevent the posts rotting, which they are very liable to do at the part immediately above and below the surface. Of all kinds of wood, larch is best suited for the posts. Let beams or joists extend from post to post, resting on and firmly spiked to them; these joists set on edge need not be more than 4½ inches by 2½ inches, or two-thirds the breadth and the thickness of a Norway batten, which kind of deal will answer the purpose admirably, and save expense in labour and stuff. Let three principal rafters of 4½ inches by 2½ inches extend from the tops of the posts to the back wall at 9 feet high, with a purline of the same scantling running across at their mid-length. Let also rafter-spars 2½ by 2 inches, cut from Norway battens of their breadth into three, proceed from the top of the joists in front, resting on the purlines and extending to the back wall, firmly fixed to a spar fastened to the wall; these small rafters should be at 2 feet intervals. And lastly, let eaves-boards ½-inch thick, the breadth of a batten, be placed across the ends of the rafters in front, and projecting 4 inches beyond the line of the tops of the posts; and similar boards across the ends of the rafters next the back wall; then across the rafters, in the space between the boards, let laths 1 inch wide and ½ inch thick be nailed at intervals of 15 inches. The shed will now be ready to receive the paper-covering, which will next be described.

"The description of paper most suitable for the purpose of roofing is that used for laying on ships' bottoms under copper sheathing, and known by the name of sheathing-paper: a very common size of which is 30 inches by 24 inches, and weighing about ½ lb. the sheet,—such size is exactly that to suit the roofing specified above. The paper is prepared and laid on in the following manner, viz.:—cover one side of the sheets of paper with hot coal-tar, and whilst the tar is still hot, dredge or sift on it as much dry sea or clear washed river-sand, well dried in an oven, as will adhere to the tar; then cover the sand, when the tar has become cold and set, with a thick coat of lime slaked with a saturated solution of alum or soda; this whitewash should be of the consistence of thick cream, with a portion of glue or other sizing matter in it. Let the sheet of paper thus prepared be laid on the roof with the prepared side downwards, and nailed to the laths with fine, short, and very flat-headed scupper nails; and so cover the entire roof with prepared sheets of paper, the edges of which must be laid as closely together as possible without overlapping. The upper side of the paper thus laid on must be thickly and evenly covered with hot coal-tar, and another stratum of paper laid upon it; after which, the outer side of this second stratum must be prepared with coal-tar and sand in the same manner as the under side of the first.

"To make the roof complete, it should be neatly pointed with Roman cement wherever it may join any wall, in order to prevent any wet finding its way in at the junction. To finish all, the whole must be covered with a limewash, described above, to which a slate, tile, or stone colour may be communicated by the addition of a little lamp-black, Venetian red, or umber. This will form an extremely durable covering, quite impervious to rain and perfectly safe from fire; and, at a very trifling increase of expense, the whole of the timber used in the construction of the shed may be rendered fireproof by being immersed for twenty-four hours in a saturated solution of alum or soda.

"At the present prices of materials and labour, the cost of shed and fold for 32 square yards, complete, according to the specification above (carriage of materials not included) will be as follows, viz.:—

	£. s. d.	£. s. d.
Timber for the shed, sawed to the proper dimensions .	0 17 6	
Labour in putting up, and nails	0 7 6	
		1 5 0
Hurdles, of larch, for fences.	..	1 0 0
Paper for covering, at 28*s.* per cwt.	0 8 0	
Preparing and laying on	0 7 0	
		0 15 0
Sundries, for levelling ground, &c.	..	0 4 0
Total	..	£3 4 0

Or at the rate of 2*s.* per square yard for shed and fold—an expense which would be repaid in a single year by the benefit that would be derived from the conveniences."

Appendix B.

The following compost is much used for the floors of malt-houses, and is suitable for the floors of barns, viz.:—After the ground on which the floor is intended to be formed is made level, let it be covered to a thickness of 3 or 4 inches with stones broken small, and well rammed, upon which let there be run, about 1½ inch thick above the stones, one part by measure of Roman cement and two of coarse sand or small gravel, mixed to a thin gauge with water. Before the above coat has become thoroughly set, lay upon it a coat of cement mixed with sand 1 to 1½ inch thick, floated to a level surface. A floor thus made is very hard, durable, and clean, and can very easily be repaired if it should by accident be broken.

Appendix C.

Should the bottoms of the excavations of cattle-boxes not be sufficiently stiff and sound to resist the draining off of the urine, 6 to 12 inches thick of *concrete* formed in the following manner will render the bottoms perfectly impervious.—Two parts by measure of lime newly slaked, and one part of Roman cement mixed together with water to a liquid gauge, and then well thickened with stones broken small, or gravel.

XVI.—*On the Construction of Farm-Buildings.* By W. C. Spooner and John Elliott.

The introduction of agricultural improvements is very frequently prevented, or seriously marred by ill-arranged and ill-constructed farm-buildings. We know of many such instances where a great expenditure has been incurred in erecting machinery, the economical working of which has been greatly impaired by the scattered arrangement of the various offices. It is, therefore, a great encouragement to the realisation of new and correct ideas on the subject in question to be enabled to begin *de novo;* and that there will be numberless opportunities for carrying improved ideas into practice

we have not the slightest doubt; for in many instances where farm buildings are getting old and expensive to repair, it will be found preferable to pull the whole down and build up again from the foundation on more improved plans, rather than, as in an instance which lately came under the notice of the writers, in which the repairs of an old barn were commenced by putting on a fresh roof, but were not completed till the whole had been rendered new to the very foundation. Besides this, both the improvements and the necessities of agriculture, whilst they tend to the removal of very small farms, tend likewise with equal or greater force to the division of very large ones, the conversion of which into farms of moderate extent requires new homesteads, and the most economical arrangement of the buildings. So that with these innovations and the bringing Downs and other lands under the dominion of the plough, which we trust will be the case in spite of the lowering cloud which at present darkens the farmer's path, it appears likely that there will be abundant opportunities for the construction of the best arranged farm-buildings.

Our object in the laying out of our plans is not merely to please the eye by their neat and pretty arrangement, nor in our specifications to show the smallest fractions for which a range of farm buildings can be roughly knocked up; but as durability, utility, and economy ought all to be regarded, we propose, whilst adding nothing that is superfluous, to supply every thing that is really required, and in such form as it will answer a landlord's purpose to erect, resting our principal claims for meritorious distinction on such economical arrangements, as will, it is hoped, save *time*, *labour*, and *expense*.

If it be a desirable practice that a number of animals should be allowed to range loose in a farm-yard, exposed, without any protection, to all the vicissitudes of the weather, and that the dung should be also scattered about and drenched with rain throughout the winter, and lose its ammonia by evaporating during the summer, we are afraid that our plans will not be approved; but believing that these practices are bad—that both the cattle and the dung ought to be protected from the weather, and believing also that the amount of goodness thereby preserved in the dung, and the flesh and fat thereby secured in the cattle, are far greater in value than the interest of the sum expended in providing such accommodation; we propose to do away altogether with the wide open space denominated a farm-yard, but to afford sufficient room for the accumulation of dung in a large and deep sunken pit covered over head.

It is scarcely necessary at the present day to employ any argument in favour of the superior economy of employing steam-power for the purposes of thrashing. The many tall chimneys that are

to be met with in the Lothians of Scotland are almost sufficient to demonstrate the advantage of the practice; and we have no doubt that the reason why steam-power is not more frequently brought to bear, in England, is owing to the ill-arranged farm buildings that are too often met with; albeit the employment of portable steam-engines appears to be on the increase, and where they are so used the corn is threshed better and at a reduced expense. We cannot fail to be struck with the fact of the superior economy of steam over horse-power, when we bear in mind that with a common 4-horse threshing machine it is hard work for one horse to put the horse-gear in motion, even when no threshing is accomplished, such is the friction of all horse-power machinery. It may be urged, however, that granting that a steam-engine is desirable on a large farm, it is doubtful whether it will pay on a farm of 300 acres. We believe that it will, and more particularly if at the same time it effects other purposes, such as chaff cutting, turnip cutting, and grinding. At the last meeting of the Royal Agricultural Society at York, we had the pleasure of meeting an excellent and spirited farmer from Cornwall, who had been in the habit of using a steam threshing-machine for many years. In the course of conversation we put the following question to him: "What do you consider the smallest sized farm on which it will answer to use steam-power for threshing?" He replied, that it would answer well on a farm of 200 acres, and he thought on less. This from a sensible and practical agriculturist we consider as very strong testimony. The advantages of having a steam threshing-machine are many, and it is by no means the least, that with it we require but little barn room, as the corn can most advantageously remain in the stack till a short time before it is wanted, a point of much importance in the erection of new buildings. We simply require a space large enough to take a rick and another convenient space to receive the straw.* It is well known that threshing should always be carried on in fine dry weather, and in such weather as this there is always plenty of work for horses on the land. We propose then, as part and parcel of our plan, that a steam-engine of

* In some recently erected farm-buildings that have come under our notice since this essay was written, and where steam-power is had recourse to, there is no space allowed in the barn for depositing a rick, it being contended that the threshing and taking in ought to go on simultaneously. We demur to this conclusion, and believe it to be a too great stretch of economy. It often happens that in this changeable climate a frosty morning is succeeded by rain or a fall of snow before noon, and then the threshing must either be discontinued, or the rick continued to be taken in during the rain. Besides which, there may not be a sufficient number of hands at liberty for both operations, though quite enough for one alone. These several advantages are quite sufficient to outweigh the saving of expense effected by limiting the barn-room, and there are also various purposes for which a covered-in building may be rendered available.—AUTHORS.

not less than 4-horse power should be used, with the firm conviction that sufficient profitable employment will be found for such machinery in threshing and winnowing all the corn grown on a well cultivated farm of 300 acres, cutting also at the same time all the chaff required for the daily feeding of some 30 fatting beasts, with the young stock and all the horses on the farm, and also grinding whatever corn or linseed these cattle and the pigs may require. By so doing we avoid the loss of time so frequently incurred in sending a horse and cart to a neighbouring mill for grist, and we also have the other advantage of using all our bran at home.

The facilities for chaff cutting afforded by means of steam-power are so great, that we would allow no rack food to be given whatever, for even in summer it will be found more advantageous and wholesome to cut the green food into chaff with straw. Having said thus much in favour of using a steam-engine, we propose to avail ourselves of another modern mechanical improvement, viz., the railroad.

The only reasons why practical science cannot be, or rather is not, more frequently rendered available in the mechanical arrangements of the farm-yard, in the same manner as in our numerous manufacturing operations, are the want of concentration that really exists and the supposed insufficiency of the amount of labour to be executed to repay a fair interest on the cost of the required mechanical contrivances. But beginning, as it were, *de novo*, and concentrating all our operations towards one point, we may, we are convinced, with considerable advantage combine the benefits of the steam-engine with that of the railroad, and thus profitably save both manual and horse labour. It will be seen that a single line of rail 4 feet apart, passes through the barn, diverging at each end into a double line, by which means we not only avail ourselves of the direct advantage of two lines through the rickyard and the cattle boxes, but we avoid the necessity of any turn-table or switches; as in taking in a rick it is only necessary to push the empty waggon on to the rail not in use, in order to allow the loaded waggon to pass into the barn. Thus we dispense with the assistance of several horses, which are generally employed in taking in a rick, as the manual power on the spot is quite sufficient to propel the waggon on the rail, and we propose to assist this by laying down the rail on an inclined plane, commencing at the extremities of the rickyard, and having a fall of 18 inches at its termination in the dung-pit; so that the labour of pushing a loaded waggon down, or an empty waggon up, the rail shall be equalized. The ricks are, of course, so arranged on the sides of each rail as to be readily loaded into the railway waggon. There are, of course, two of these trucks

required, one being loaded and the other unloaded at the same time; they will merely require to be a light frame-work on four wheels, and may be constructed at the cost of 15*l*. If necessary, a rick can be taken in and threshed and winnowed at the same time; but on a small farm it will probably be more convenient to carry on these operations on different days. It will, however, be quite unnecessary to have more barn-room than is sufficient for one rick, as corn of every description can be kept much better in stack than in barn. If the expense of thatching is objected to, this may be obviated by having a moveable roof, made of thin board, on a light frame, and covered with felt, and hoisted up and lowered on a long pole running up through the middle of the rick, or on four poles on the outside.

To return, however, to the rail. We have seen that it effects a saving of horse-power in taking ricks into the barn, but it will also serve the still more useful purpose of economizing manual labour in the daily feeding of cattle; for which object we have two lines of rail, each running through a double range of cattle-boxes.

The Cattle-Boxes.—In deference to the opinion of many excellent judges, we have allowed the space of 10 feet square to each fatting beast, believing that box-feeding with linseed compounds* is the best and cheapest method of manufacturing beef, and at the same time preserving the goodness of the dung by compression, for which latter purpose each box is sunk 18 inches in the ground. However, where litter is scarce, or a greater number of cattle are required to be accommodated, it is only necessary to convert each box into two stalls; but whether boxes or stalls are preferred, we propose to have under-ground drains under each—these drains discharging into the manure-tank.† The saving of litter by thus draining away the liquid portion of the manure into the tank is, we take it, very great. It must be confessed that one of the principal arguments in favour of boxes over stalls—viz. the capability of preserving the dung in a compressed state and under cover—is in some degree rendered less striking by means of our

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* In consequence of the high price of linseed-oil, the cost of linseed so greatly exceeds that of linseed-cake that the use of the latter will be found more economical. It may, however, be readily ground into meal, and used as mucilage mixed with chaff or other food.

† Some amount of expense may be saved by availing ourselves of the combined advantages of box and stall feeding in this manner:—When the beasts are first put up, being light in flesh, they do not require so much space as subsequently. Two therefore may be tied up in each box, the dung being removed as it accumulates by means of the tramway into the covered dung-pit. As the beasts are fatted off, and their numbers lessened, the fattest of them may be allowed the entire box, so that, by the time one-half are gone, box-feeding will be in full operation; and at the end of the term the boxes will be left full of good dung, and the manure-pit likewise. Thus double the number of beasts can by this plan be fatted off with the same amount of building as by ordinary box-feeding.—Authors.

arrangements, which admit of the dung being daily removed from the cattle with very moderate labour, and deposited in the covered manure-pit, so that we take it the question of "adopting boxes or stalls" must very much depend on the abundance or scarcity of litter on the farm.

If, instead of fatting beasts, a dairy should be preferred, the arrangement of our covered cattle-sheds and the assistance of the railroad will be equally available. While, however, we advocate most strongly the preservation of every particle of manure, we dissent from the doctrine that beasts are to be kept merely or expressly for the purpose of making dung, and that for this desideratum a loss may be submitted to on each head of cattle with impunity. The legitimate object of fatting cattle is to convert the produce of the farm into a concentrated and marketable form, securing at the same time the manure voided by the animals. To do this advantageously, it is often desirable to use linseed and corn in conjunction with roots and hay, thereby making the more bulky food go further, and thus fatting off the animals in a shorter space of time. So far so good; but to go beyond this, and to keep an enormous quantity of cattle in proportion to the extent of the farm, as is sometimes done, feeding them principally on purchased food for the purpose of making manure, is at best but manufacturing that at a great cost which can be more advantageously purchased in the form of Peruvian guano or other concentrated manures. We have therefore extended the accommodation of our cattle-boxes only to that amount which can be warranted by *high* though at the same time *legitimate* farming.

It will be seen that our covered houses for young stock, and also our calf-pens, are placed at the extremity of the cattle-boxes, so that the same system of feeding can also be adopted with reference to them.

We have presumed that cattle-feeding forms a prominent object on our farm; but if it be wished to substitute the shed-feeding of sheep, our arrangement will be found equally applicable. It will require very little alteration, if feeding sheep in *pens* is preferred, and not much extra expense to adapt the space to the *stall-feeding* of these animals. In each case a framework of wood must be used, allowing the manure to drop through into the pit below, from which the more liquid part drains off into the manure-tank. The piggeries occupy a tolerable amount of space in our plan, with a view of accommodating a large number of pigs; for we believe that no animal will pay better for food and systematic arrangements, both with regard to warmth, comfort, and the economy of food. Believing that exposure to cold and wet robs the fatting animal of that which would otherwise become fat, and that the manure is also deteriorated, we propose placing both under

cover, and here box-feeding may be again rendered available. With regard to the store-pigs, they may have open yards attached to the piggery. One reason why the fatting of pigs frequently does not pay, is because, as soon as they have begun to taste barleymeal, they refuse to eat swedes and other cheaper food. If, however, the roots are boiled, they will eat a considerable quantity in addition to the meal, and thus can be more cheaply fatted. Unless, however, suitable apparatus is constructed, the trouble of preparing roots is so great as to preclude their use. We have therefore added a boiling-house, which is situated near the piggeries, and where both the food for the pigs and the linseed compound for the cattle may be conveniently prepared.

At the bottom of the piggery we have given a large shed, which may be conveniently used as a lambing-house, and where the ewes can be driven nightly during the lambing season with great advantage. This space admits of considerable extension by means of hurdles, when the whole of the space between the cattle shed, the piggeries and the lambing-houses can be thrown in.

It may, perhaps, be urged as an objection to our plans, that on a farm of the smallest size, comprehended by the terms of the Society, a rail is an unnecessary outlay, and that the amount of labour to be saved thereby is not commensurate with the expense incurred. We demur to such a conclusion; but at the same time we believe that the economical construction of our buildings will hold good even where the expense of a railway is not incurred, and we think it difficult to point out a different arrangement of the buildings by which time or labour can be saved. We have, however, a right to presume, that on a farm of the size stated, the best system of cultivation will be carried on, and by the aid of ample capital that every improvement that can be shown to pay itself will be readily adopted.

The same observation will apply with almost equal force with reference to the steam-engine, which, if dispensed with, there would then be required but little re-adjustment of the building; the only alteration will be the conversion of the engine-house into a root-store, and the space occupied by the present root-house and shed will afford room for a horse-power threshing-machine.

We have arranged our buildings as the plan in its integrity now stands, on the supposition that a steam-engine would be employed, and we have been careful to place that engine in the spot where its power could be exerted with the least possible amount of connecting machinery. The hardest work that engine will have to do is to keep the threshing-machine going; power is therefore immediately communicated from the axle of the fly-wheel to the threshing-machine, which stands over a platform projecting over the barn floor, and about 7 feet above it; the corn threshed out

falling immediately into the winnowing-machine under, from whence it issues ready for sacking.

The turnip-cutting machine may also be worked from a continuation of the fly-wheel axle in the opposite direction. From the fly-wheel itself, by a band, motion will be communicated to the chaff-machine which is over the hull-house, to the grinding-mills which are over the grist-house, and in that room to the bolting apparatus. Over the engine is to be placed a large tank for the supply of the boiler, and the water in this tank we propose to heat by the steam that is blown off, and also by taking the boiler-flue round it, so that the water passing into the boiler will be hot before entering it. This tank will be filled by the engine, and if always kept full offers a ready means, by connecting a hose with it, of extinguishing a fire in its commencement either in the rick-yard or buildings. The engine itself, so soon as it can be got into action, would of course be applied as a fire-engine, and this advantage may be considered to meet any objection that may be raised that the proximity of the ricks to each other might render a fire more destructive.

It must be very desirable that the farm-buildings, as well as the rick-yards, should be constantly under the watchful care of the yardman, and we propose that his cottage should be so placed as to command the whole of the rick-yard and the farm-buildings; a position at the east angle of the buildings will effect both these objects to the manifest advantage of the stock and the security of the ricks and buildings from damage by fire, whether occasioned by accident or design; and there would be this additional advantage in a cottage so situated—that of economising the time and labour of the overlooker. The drawing of the points of the compass on our plan will be about the spot for such a cottage. We have shown these points of the compass to indicate the position the buildings should be placed in; aspect should never be neglected in any building, and it is very desirable that the north and south line should pass diagonally through the buildings, every part of which would thus secure the sun's rays during some portion of the day, whenever the sun may think proper to shine. Under the engine-house we propose forming a tank of rain-water which would be filled from the roofs of the barn, sheds, and cattle-boxes: this water would be desirable for the cattle, would give the engine less work in pumping, and would also be useful in case of fire.

As before stated, the railroad has a fall of 18 inches from its points of commencement in the rick-yard to the dung-pit, where it terminates. We will suppose it is employed for taking in the ricks; the truck will then enter the barn and deposit its load in the right-hand compartment of the barn, or the corn may, if

threshing is going on, be immediately transferred to the machine which abuts on the railway. The root-store is to be filled by aid of the truck from the root-house and root-shed; the former being a lock-up house for potatoes and carrots, the latter an open place for the deposit of other roots between hurdles.

When the cattle are to be fed, the truck takes up their load of roots, cut or boiled, in the root-boiling and cutting-store, or the chaff and linseed compound for another meal, obtained each from their respective store-houses adjoining the rail, and proceeds on its way through the cattle-boxes, giving out to each animal its appointed allowance. The trucks are again available for littering the animals, procuring the supply from the straw-barn; and when the accumulation of manure in the boxes has reached its limited height of increase, the trucks convey this mass of dung direct to the dung-pit. One man could thus easily by means of the rail and truck manage all these operations in a short time, so that the whole of the animals might receive their food with regularity. Even if the railway be not adopted, such an arrangement of building as we have shown, would afford great facilities for feeding and littering the stock; the inclined plane from the various store-houses through the cattle-boxes may be still retained, and if a plank were laid down and securely fixed in the centre of the passages between the feeding-boxes, a man would be able to take a good load on a long frame wheel-barrow; the expense of laying down such planks would not exceed 10*l.*

From the root-boiling house the distance is but short to the piggeries; in front of these, troughs are placed, having swinging flaps for convenience in filling and feeding.

The straw-barn extends under the granary, and at its side and end has the space up to the roof. The hay-shed and the straw-barn are thus both brought close to the chaff-cutter. The granary is placed in its present position in order that, as the corn sacks are filled, they may be hoisted up at once to their place of deposit, and be convenient for transfer to the mill-room; or, if the corn is to be sent away for sale, the waggons would pass through the barn and the sacks be dropped into them direct from the granary door. To prevent any risk of vermin getting into the granary, it is proposed to form the floor of inch slate, and the sides and ends of the binns to be also of slate.

The fowl-house is over the root boiling-house, and in this position they would be likely to thrive, the room set apart for them being very dry and warm.

The cart-horse stable is placed close to the waggon and cart-shed, which will take two carts, one behind the other, that no loss of time should occur in getting the teams off in the morning, or in taking the tired horses at night into their place of rest.

The stable affords ample accommodation for ten cart-horses and two nags, having a convenient harness-room and hull-house. A large tank for rain-water is added, supplied from the adjacent roofs, and having, if necessary, a supply-pipe from the engine cistern, so that, while the engine is being used, warm water can, if required, be obtained in the stable.

In our plans we have afforded no space for a pond, as we believe such an addition within the precincts of the farm-buildings is quite unnecessary. The horses should never be allowed to go into a pond to drink *ad libitum*, such a practice being a fruitful cause of both external and internal disease.

We do not recommend that any hay should be given except in the state of chaff, no loft therefore is required, and the litter and chaff will, on the trucks, be brought opposite and tolerably close to the stable door.

The dung-pit has three doors, each wide enough to admit a cart, whether employed in removing, adding to, or compressing the manure, either to pass up or down on the dung as that may be high or low in the pit. The liquid portion passes off into the adjacent underground tank, which receives also all the liquid manure, undiluted by rain-water, from the piggeries, stable, and cattle-boxes, drains being laid from all these places to the tank in question. A pump fixed over this tank would fill a liquid manure-cart, or by means of a short hose proceeding to the dung-pit or to the artificial manure and ash-house, affords the means of saturating the dung, ashes, or earth with liquid manure previous to being carted out on the land.

The floors of the cattle-boxes are formed 18 inches lower than the passages between them, and the litter is allowed to accumulate till it reaches to 18 inches above the level of such passages. The feeding troughs must thus be made moveable, and the rails which bar the entrance, will also require to be made to shift; the divisions, as high as 3 feet, are formed of walling, and above this, of posts and open railing, wide enough apart to allow of the cattle getting their heads through, as the litter will thus be better trodden down.

The roofing over these cattle-sheds is of the simplest construction. There are no gutters here, or indeed in any part of the building, but the water is caught in the iron eaves' spouts. Light, air, and ventilation are obtained by the manner in which the passages are roofed over; in snowy weather, violent rain or at night, wooden flaps (hinged to the end of the rafters, and doubled-up under them in convenient lengths), by means of a cord passing over a wheel, are let down and thus keep the snow or heavy rain from drifting into the passage. The whole of the other roofs are of very simple construction, requiring only timbers of very small scantling.

In the cart-house and barns the roofs are divided into two spans by upright posts supporting the ridge-piece, to which the common rafters are suspended by iron straps, thus obviating any tendency in the roof to spread or thrust out the walls.

It is presumed that in the barns these posts in the centre would be useful, and they certainly would not be found in the way in the cart-house. It is proposed to construct the whole of the walling with hollow tubes of baked clay, of which specimens are sent. Through the kindness of the Duke of Richmond, the opportunity was recently afforded us of making a practical trial of this method of construction; and from the experience we have now had, we feel no hesitation in pledging ourselves, that with ample strength and equal durability, as compared with common brick walls, our method of construction with these hollow tubes will effect a saving of one-third in the cost per rod of walling.

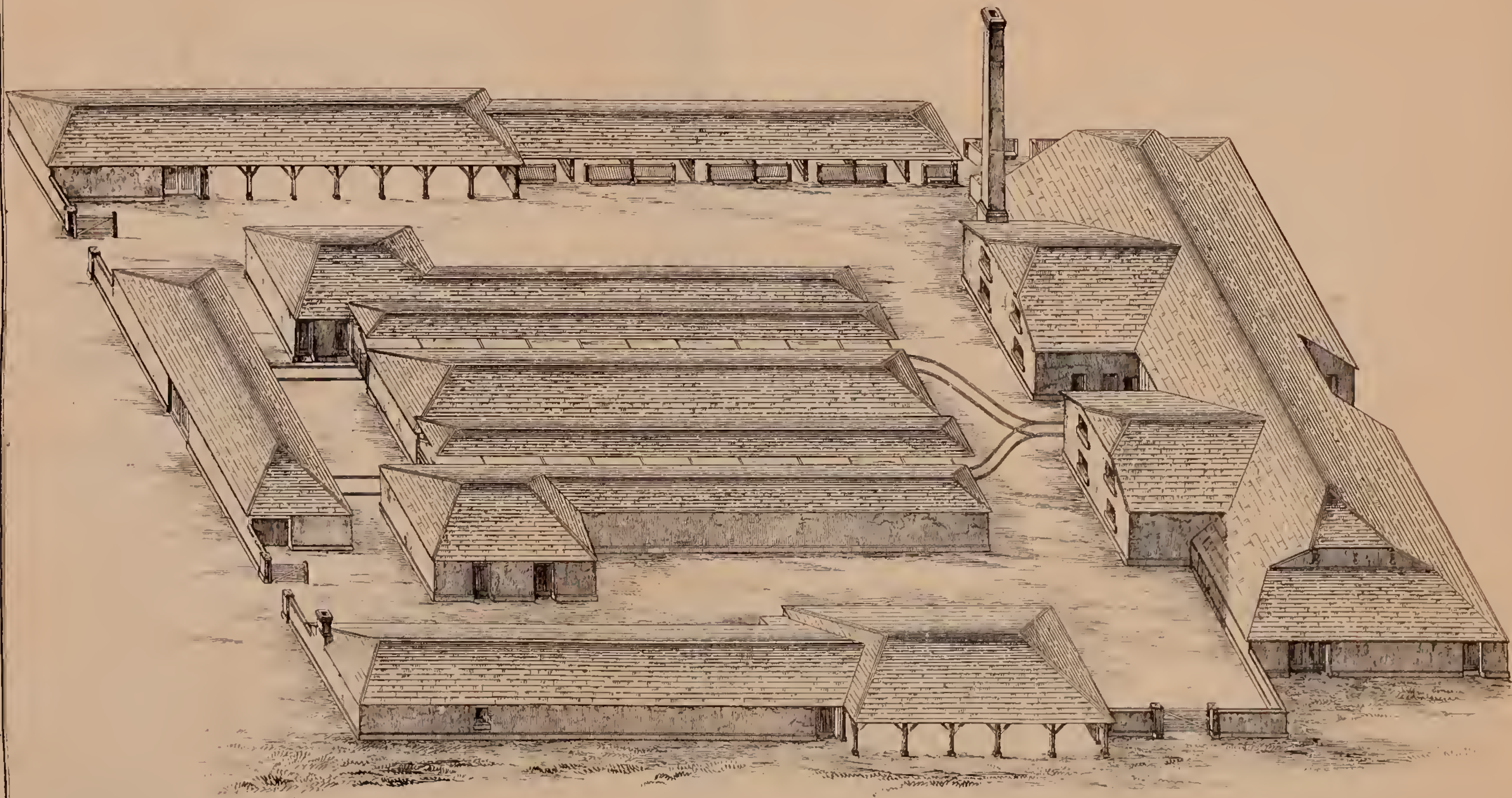
The geometrical ground-plan, having the names of the various compartments written on it, will serve as a key for the isometrical section and elevations, which with the other sections, scales, and figures will afford sufficient explanations to enable any country carpenter to put up such a stack of buildings, in the arrangement of which, simplicity and convenience have been chiefly studied, combined with economy, strength, and durability—such beauty only being attempted as was to be obtained by regularity and form.

The *we* that has been employed in the foregoing observations is not the "editorial we," its use having arisen from the fact of this essay and the accompanying designs and arrangements being the joint production of two parties, the one a practical architect, the other an agriculturist, each having had ample opportunities and a tolerable amount of experience in their respective occupations. This circumstance, it is hoped, the Council will consider as some guarantee for the correctness of the authors' calculations and the justness of their views.*

Estimate and Specification for Farm-Buildings.

Yds.	ft.	in.		s. d.	£. s. d.
84	0	0	Cube digging to liquid manure tank . .		
212	0	0	" " covered dung-pit . . .		
50	0	0	" " water-tank		
227	0	0	" " cattle-boxes		
178	0	0	" " foundations		
Rods	ft.	in.			
29	50	0	Superficial reduced brickwork with tubular bricks		

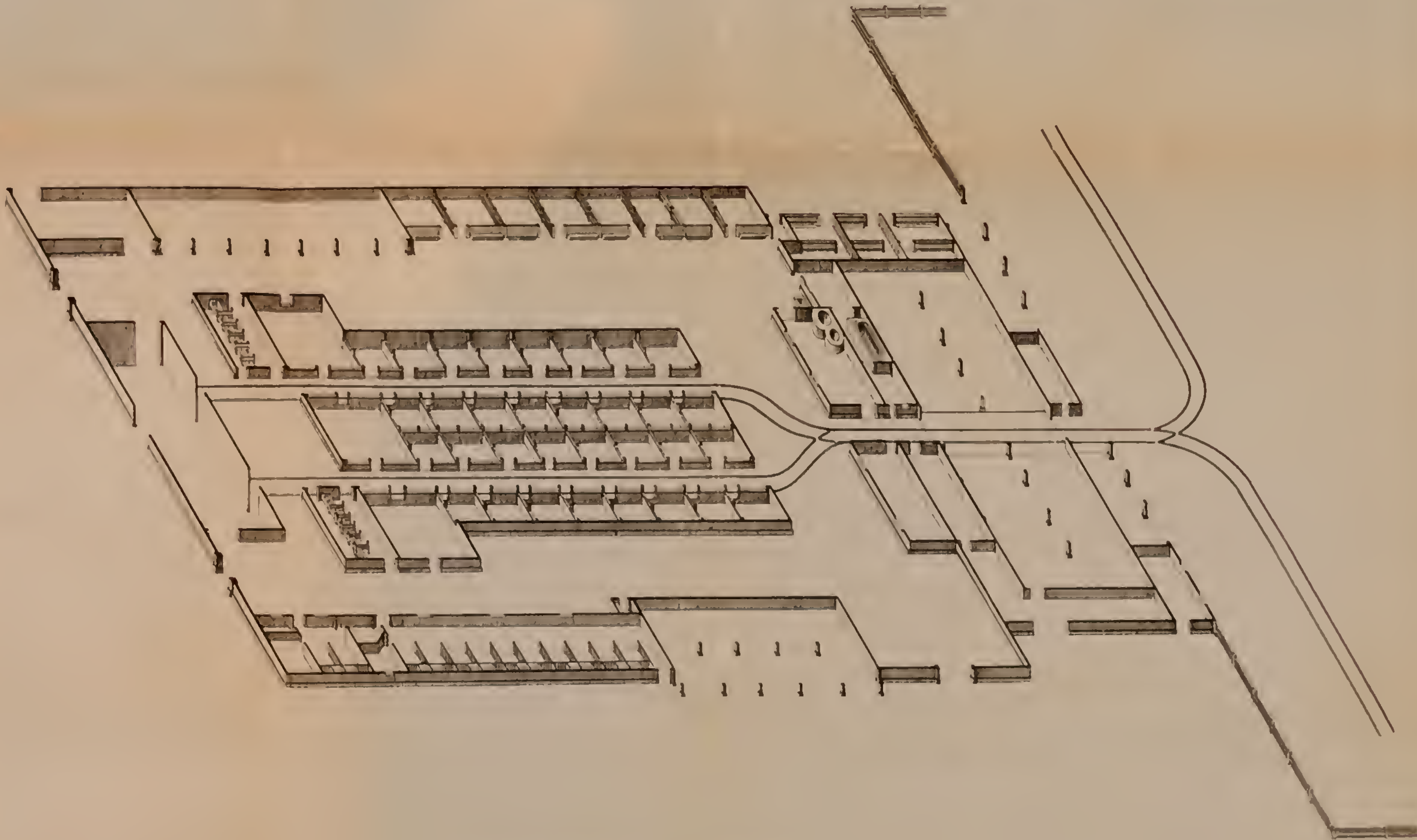
* The first part of this essay was written by Mr. Spooner, the latter by Mr. Elliott.



ISOMETRICAL ELEVATION.

John Elliott, Architect, Southampton & Chichester.

Standidge & Co Litho Old Jewry London



ISOMETRICAL SECTION.

John Elliott Architect

Estimate and Specification for Farm-Buildings—*continued.*

Yds.	ft.	in.		s. d.	£. s. d.
	74	0	Run coping bricks to wall		
718	0	0	Superficial lime ash floors.		
481	0	0	„ „ „ to cattle-boxes . .		
170	0	0	„ brick edge paving . . .		
103	0	0	„ brick-flat paving		
Squ.	ft.	in.			
183	79	0	„ ladies slating		
66	64	0	„ „ to cattle-boxes . .		
	ft.	in.			
	315	0	„ 1 slate floor to granary . . .		
	194	0	„ 1 slate binns to granary. . .		
	141	0	„ ¾ slate lining to partition of granary.		
	1058	1	Run capping to ridge and hips . . .		
	457	6	„ „ „ „ to cattle-boxes .		
			No. 38 post stones		
Cwts.	lbs.				
7	21		Milled lead to valleys		
Yds.	ft.	in.			
37	0	0	Superficial cementing with two course of tiles to bottom of tanks		
98	0	0	Superficial cementing with one course of tiles to sides of tanks		
			Lime whiting and colouring		
Squ.	ft.	in.			
180	49	0	Superficial battening for ladies slating . .		
61	32	0	„ „ „ to cattle-boxes		
11	42	0	Superficial 1 rough ploughed and tongued floor.		
9	4	0	„ ¾ boarding to partition of granary .		
5	60	0	„ 1½ dowelled floor to barn . .		
Yds.	ft.	in.			
	1985	0	Cube Memel		
	670	0	„ „ to cattle-boxes		
	53	0	„ „ stall post and rails . . .		
	25	0	„ Oak joist to barn floor . . .		
	528	0	Superficial boarding to stalls of stable . .		
	40	0	„ 2-inch till-board		
	257	0	„ ¾-inch ledged swinging-boards to piggery		
	171	0	Superficial ¾-inch rough boarding to piggery .		
	66	0	„ ¾-inch ledged doors to piggery .		
	618	0	„ ¾-inch clamped flaps to sides of roof of feeding passages		
	9	0	Superficial 1-inch privy seat and riser . .		
			No. 3 farm-yard gates with oak posts and tills .		
			„ 2 barn doors and frames 11 feet × 10 feet .		
			„ 5 2-inch wrought framed and braced doors and frames 7 feet × 4 feet. . . .		
			No. 4 2-inch wrought framed and braced doors and frames 8 feet × 7 feet. . . .		
			No. 26 ¾-inch ledged doors and frames 6 feet 6 in. × 3 feet		
			No. 14 iron casements and frames 4 ft. × 2 ft. 6 inches.		
			No. 5 iron casements and frames 3 ft. × 2 ft. 6 inches.		
			No. 12 troughs to calf-houses at 4 feet long .		

Estimate and Specification for Farm-Buildings—*continued.*

Yds.	ft.	in.		s. d.	£. s. d.
			No. 32 troughs to cattle-boxes at 4 feet long .		
			,, 11 ,, piggery at 4 feet long . .		
			,, 12 ,, houses for young cattle 4 feet long		
			No. 1 step ladder to mill-room . . .		
			,, 12 racks and mangers		
126	0	0	Run light iron rail and sleeper (no chairs required) 10*s.* per yard		
	610	0	Run iron shoots		
	110	0	,, ,, stack-pipe		
	250	0	,, 4-inch earthenware drain-pipe in cement .		
	240	0	,, 9-inch ,, ,, ,, .		
			Tarring exterior wood-work		4 0 0
			Total including railway . . .		1438 16 5
			Extra.		
80	0	0	Run light iron rail and sleeper for rick-yard, if that part of the plan is carried out . .		40 0 0

XVII.—*A Plan for Farm-Buildings.* By J. Hudson, of Castleacre.

In thus attempting to offer an opinion upon the construction of farm-buildings, I feel I may be deficient in the ability to frame an Essay in eloquent language; but if a life devoted to practical farming can furnish a plain unvarnished statement of what, from experience, I find is required in a farm premises, then I hope the plan I am about to submit may be found advantageous to the tenant farmer.

Presuming the plan required is for 300 acres of arable land, I would first premise that in the selection of the site for buildings it would be advisable to have them placed, as nearly as possible, in the centre of the occupancy, both for the advantage of carrying the corn to be threshed, and a portion of the root crops to the cattle-yards, as well as the carting the manure from the yards to the fields, and also the economy of time in the men and horses having only a short distance to go from the stables to their work in the fields. Another very important thing is the supply of water for the cattle, and also for steam-power, should it be used upon the premises, in which case large expensive barns are not required to be built.

It may be thought that the accompanying plan is larger than is

necessary for a farm of 300 acres, but I consider it good policy on the part of the landlords of England to provide their tenants with ample accommodation in the way of farm-buildings, to enable them to cultivate the land highly, so as to grow as heavy root crops as possible; and I never knew a farmer having capital sufficient who would allow a good grazing-yard to be without stock during the grazing season.

Farm-buildings are frequently too much crowded together for the sake of being considered compact; and I would by no means recommend the yards opening one into the other, as there is great liability of the cattle getting together and injuring themselves: the possibility of this is avoided by the plan I have drawn out.

The cattle-yards should front the south; and it will be seen by the plan that the stables, cart-shed, &c., are on the south side of the long court-yard; between them and the cattle-yards the cold winds of winter will be sufficiently kept out, and yet the warmth of the sun will be admitted to the grazing-yards, which is a great advantage, the court-yard being 60 feet wide.

The cattle-yards are 64 feet square, including the sheds, which are 16 feet wide; so that each yard will hold from 12 to 15 head of cattle, and some of the sheds might easily be fitted up as loose boxes, if required, at a small expense.

In the county in which I farm it is usual, upon almost all large farms, to have a field-barn and grazing-yards for the accommodation of the distant part of the land, by which means much labour and carriage of manure are saved, and 200 or 300 acres of that part of the farm can thus have farm-yard manure applied to it, which would seldom have it were it not for the extra premises.

Respecting the cart-horse stables care should be taken that they are well ventilated by a cupola or two over each stable; these may be made of zinc or galvanised sheet-iron, and in the centre of each outer door should be an iron slip frame 18 inches square, to admit air if required, and windows to the south, of strong agricultural glass; also a drain from the centre of each box to the sewer, to convey the liquid manure to the tank, No. 26.

The keeping of cart-horses is a very important item in the economy of the farm; they require at all times to be in good condition, and always ready to do a good day's work.

Each horse should have his loose box fitted up with iron manger for chaff and corn, another for cut hay, and an iron trough for water; by this means each horse would have the quantity of corn allowed by his master, and not just what the carter chooses to give him.

Having said thus much, I will now endeavour to explain the buildings in rotation.

I will suppose the farm-house to be placed some 40 or 50

yards on the east side of the farm-yards. On entering the court-yard on the right hand are the piggeries, No. 1.

No. 2, a house for bull.

No. 3, cow-house or milking-house; a door to the east from the farm-house.

No. 4 is a calves' pen.

No. 5, cow-yard with open shed.

No. 6, yard for young cattle, or for grazing, with open sheds.

No. 7, 7, hay-house and straw-house.

No. 8, 9, coal-house and engine-house.

No. 10, threshing-house, with floor above for threshing-machine and straw-shakers, the grain falling into a dressing-machine below. And here it may be proper to say a few words upon this important part of the farm-buildings.

In this improving age it would be unwise to recommend the building of large and expensive barns, the more especially as steam-power is getting into such general use. I can speak practically upon this point, as I am now using two steam-engines upon my farm. One a stationary engine, which, besides driving a threshing and dressing machine, works an oil-mill, for the purpose of making linseed cakes for my cattle, and also grinds the inferior or tail-corn for them; the other is a portable engine, which only drives a threshing-machine and straw-shaker at an off barn in the centre of 300 acres of arable land, where 60 head of cattle are annually grazed in the yards upon Swedish turnips, mangold, and linseed cakes.

The corn is threshed for one-third less than what it would cost were it done by horse-power, and the horses can be more profitably employed upon the farm at other work: the saving is very great, the cost of moving, threshing, and dressing a stack of mown wheat by steam-engine being 10½*d.* per quarter; and the same by horse-power, 2*s.* 6*d.* per quarter.

The expense of moving in and threshing and dressing a stack of mown wheat, containing 90 coombs, by the stationary engine, is 5¼*d.* per coomb of 4 bushels, as may be seen by the statement here given.

STEAM-POWER.

Cost of moving a stack of mown wheat, threshing and dressing 90 coombs:—

	£.	s.	d.
2 Men, 1 day at stack	0	3	4
2 Men, 1 day loading	0	3	4
1 Man, 1 day raking loads, binding, &c.	0	1	8
1 Man to feed machine	0	2	6
1 Man attending to corn	0	1	8
1 Man unloading wheat	0	1	8
2 Men putting sheaves to feeder	0	3	4
Carried forward	0	17	6

	£	s.	d.
Brought forward	0	17	6
1 Woman putting out straw	0	0	10
2 Men after straw	0	3	4
1 Man and 3 Women dressing	0	4	2
1 Man driving engine	0	3	6
Half ton of coals	0	10	0
	£1	19	4

Being 5¼*d.* per coomb.

I have another barn, at which is a horse-power threshing-machine for 6 horses, and the cost of moving in a stack of mown wheat containing 90 coombs, threshing and dressing the same, is 1*s.* 3*d.* per coomb of 4 bushels.

Horse-power.	£.	s.	d.
5 Men at stack	0	8	4
4 Men in barn	0	6	8
1 Man, 1½ day feeding	0	3	9
1 Man, 1½ day driving horses	0	2	6
2 Men, 1½ day in barn	0	5	0
1 Lad, 1½ day untying sheaves	0	1	6
5 Women to shake straw	0	6	3
2 Men, 1½ day after straw	0	5	0
3 Men, 1½ day to riddle and clear away corn	0	7	6
6 Men and 4 women, 1 day dressing	0	13	4
6 Horses, 5 hours threshing, at 3*s.*	0	18	0
6 Do. 5 do. do. 3*s.*	0	18	0
Do. 5 do. do. 3*s.*	0	18	0
	£5	13	10

Being 1*s.* 3*d.* per coomb.

Nos. 11 and 12 are two grazing-yards 64 feet square, including the shed, which is 16 feet wide.

Nos. 13 and 14 are turnip-houses opening into each yard, from whence the cattle can all be fed.

No. 15 is intended for a carpenter's workshop, which is a very requisite building.

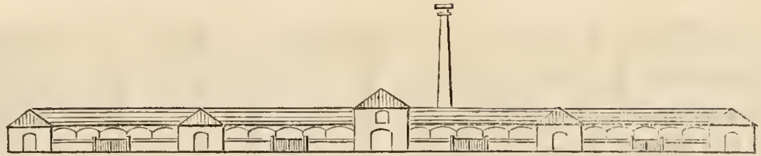
No. 16, the cart-shed with granary over; the granary to be in the roof 14 feet wide.

No. 17, house for harness, &c.

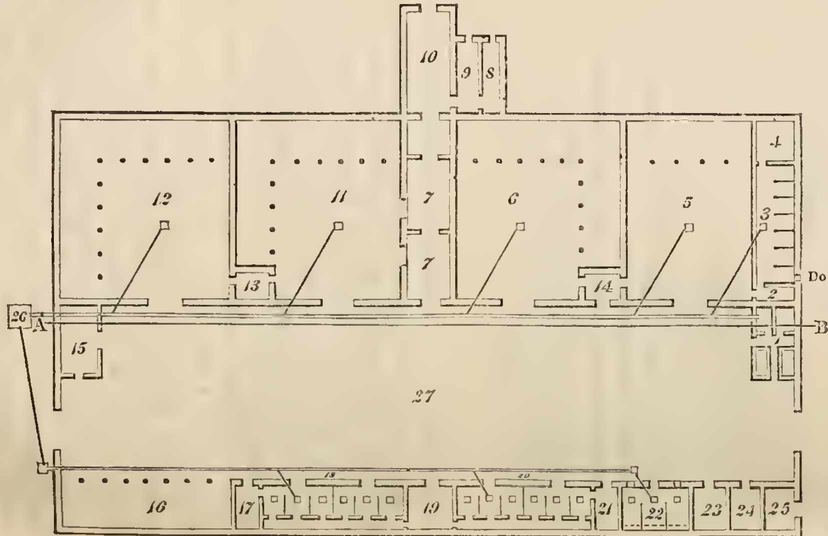
No. 18, cart-horse stable, divided into 6 loose boxes, each box fitted up with 2 iron mangers and iron water-trough.

No. 19, corn and chaff-house 20 feet square, with granary over for horse-corn. Here the food for the horses can be prepared by the yard-man, and the horses fed by him at the head of the horse-boxes. By this plan each horse would have exactly what corn the farmer thinks proper to allow him; but I would by no means recommend the litter to remain more than one day in the horse-boxes, but cleaned out every day and put into the cattle-yards.

PLAN OF FARM BUILDINGS, FROM 250 TO 300 ACRES—ESTIMATED COST £1500.



SOUTH ELEVATION on Line A. B.



REFERENCE.

No.
1. Pigs' House.
2. Bull House.
3. Cow House.
4. Calf Pen.
5. Cow Yard.
6. Young Cattle.
7. Hay and Straw.
8. Coal House.
9. Engine House.
10. Barn.
11. Cattle Yard.
12. Do. do.
13. Turnip House.
14. Do. do.
15. Carpenter's Shop.
16. Cart Shed and Granary.
17. Harness House.
18. Cart Horse Stable.
19. Corn House and Granary.
20. Cart Horse Stable.
21. Harness House.
22. Nag Stable.
23. Gig House.
24. Wheat House.
25. Fowls' House.
26. Reservoir—Liquid Manure.
27. Yard.

10 5 10 20 30 40 50 60 70 80 90 100

The more the horse-manure is mixed with that of the grazing cattle the better; and the small expense of carrying it into those yards daily will be amply repaid by the improvement in the quality of the manure.

No. 20, six more loose boxes. The whole of the boxes should be divided 4 feet high with board 2 inches thick, and then 2 feet more with strong rails of either oak or elm. It will be observed, that three of the horses will enter at one outer door, one going into his box to the right, another to the left, and the other the centre box.

No. 21 is another harness-house.

No. 22 is the nag-horse stable, fitted up with two stalls and a loose box.

No. 23, gig-house.

No. 24, house with copper and furnace for cooking and steaming food for pigs, &c., and for preparing seed wheat, &c.

No. 25, house for fowls.

No. 26, liquid-manure tank—the drains from the yards all emptying themselves into it.

I have thus enumerated every building required for a farm of 300 acres of arable land; indeed, it might suffice for nearly 100 acres more, unless an extra capital was employed to grow heavier root-crops, and by that means keeping a larger number of cattle. As a matter of course, the buildings should be all fitted up with cast-iron water-troughs to convey the water from the eaves, so as none of the water from the roofs of the buildings be allowed to fall upon the manure in the yards: too much attention cannot be paid to this.

An excellent plan is now being adopted upon a large estate in this county of using deal board instead of rafters in all the cattle-sheds and stables, where they do not exceed 20 feet in width. Three purlins, or side-pieces, are used instead of one as formerly, and these are cladded over with board 1 inch thick from the ridge to the eaves, and the slate is fastened to these boards, by which means neither rafters nor lath are required, and the slates are never blown off by the wind; nor can the rats or birds interfere with the roofs of the buildings.

Stone should be used for the bottoms to set the oak posts upon in the cattle-sheds; the cost is less per foot than oak, and it will last much longer.

The cattle-sheds being 16 feet wide can easily be converted into loose boxes if required, having ample room for a path 4 feet wide, so as the cattle can be fed at the head without going into the boxes. In either case they should be fitted up with cast-iron mangers attached to two upright posts, so as they may be raised up a few inches at a time, as the manure increases in height in the shed or boxes.

The yard-gates ought to be of the best oak and made very strong, and not less than 5 feet high.

The cost of building this farm premises may be thought excessively high, but the estimate is made upon the understanding that the very best of materials are to be used, as well as the best of workmanship. Where the bricks can be made upon the farm, and English fir used, the cost would be much less in the first instance; but foreign timber would be cheaper in the end. It is intended to have all the posts, door-jambs, &c., which are exposed to the weather, of English oak.

Specifications of Farming Buildings for a Farm of 300 *Acres.*

The building to be built with bricks, and covered with slates; roofs, &c., Memel timber; oak jambs, posts, &c.; stone bottoms to the story posts of lodges and sheds.

All the yards and buildings to be drained, and the water carried off by a common sewer into a reservoir for liquid-manure. The yards to be laid with a fall from each side to the centre to a tank, with grating thereon.

The piggeries to be partitioned into folds, with paved floors; bull and cow-houses, and calves' pen, to be paved and fitted up with stalls and feeding-manger.

The sheds in cow and cattle yards to be fitted up with feeding-cribs. The story-posts to stand on stone bottoms.

Cart-shed, story-posts standing on stone bottoms. Granary to be made over the waggon lodge in the roof, 14 feet wide.

Cart-horse stable to be made with six loose boxes in each; to be fitted up with iron mangers, rack, and water-trough; to be fed at the head. The stores to be kept in corn-house No. 19, with a granary over the same.

The riding-stable to be fitted with two stalls, and one loose box.

The barn to be built with two floors; the first floor to be of brick, and the second floor to be boarded for threshing and dressing corn, &c.: the threshing to be done by machinery, worked by steam or horse-power.

Estimated expense, 1500*l.*

XVIII.—*Farm-Buildings.* By Thomas Sturgess.

The essential buildings of a farmstead are those which will enable the farmer to house and thresh his corn, convenience for the storing of the straw, preservation of the manure, shelter for fat cattle, milching cows, farm-horses, and other live stock kept upon the farm; also convenience for the housing and preparing of the various descriptions of food which they consume, shelter for waggons, carts, and other agricultural implements used.

In examining into the present state and condition of the farm-buildings of this country, they are generally found to be in a very defective state both as to convenient arrangement and quality of

buildings; also, the accommodation is scanty compared with what is really requisite in these times of improved husbandry; and, in examining the additions which have been made within the last twenty years, there seems to have been no well considered or pre-arranged plan, but merely added to at the most vacant spot of ground, without any regard being paid to the convenient arrangement of the whole buildings. Of course there are some few exceptions; and on an estate of the Duke of Northumberland's at Stanwick, I may mention that the greater part of the farmsteads have been, within the last ten years, altogether remodelled and rebuilt on the most improved principles; and there is another estate in the same neighbourhood where the same desirable object has been carried out; but such advances in the improvement of the farm-buildings of the kingdom are rarely to be met with.

In taking, therefore, into consideration the situation and arrangement of a full set of farm-buildings suitable for a farm of the extent of from 250 to 300 acres, I may observe that the quantity of buildings which a practical farmer requires differs in a slight degree as to the *quantity* of them, according to the character of the soil of the farm which he may occupy, which may, for instance, be a light sandy soil, and require the bulk of the turnip crop to be eaten on the land by sheep. In this respect then the extent of beast-houses will be diminished, while the rest of the necessary convenience remains the same when the acreage is equal.

I will now consider, in the first place, the selecting of the most advantageous situation. The first impression which strikes one, in fixing upon the situation for the erecting of a farmstead, would be to place the same near about the centre of the cultivated grounds, as the cereal crops, having for the most part to be taken to the farmstead and consumed by the cattle, would again have to be returned to the fields in the shape of manure, the advantages in the saving of labour would be very great in thus placing the same near the centre of the cultivated grounds. But there are other considerations of a primary importance which ought not to be overlooked; and the first is, is there a sufficient command of water in any part of the farm, not only for the use of the live stock as well as for household purposes, but can it be obtained in sufficient quantity to be used as a power? If it can, then it is of the utmost consequence that the same be secured: for I am of opinion that on a farm of the extent under consideration, if water power cannot be obtained, a steam-engine is requisite; for, in the first place, the threshing with horses is very hard work, and no work of any kind seems so much to distress them; further, you cannot conveniently obtain that necessary power which you really require with horses, for you ought to have, in connexion with your corn-threshing machine, a chaff-cutter and a pair of stones to grind

coarse meal and bruise linseed. I may mention here, in connexion with the desirableness of either obtaining water power or a steam-engine, that I am personally acquainted with many farmers using their 500 to 1000 bushels of coarse meal and 100 bushels of linseed in a winter for the feeding of live stock.

Another consideration which is of some importance in connexion with the situation, and that is—is there a good public road running through or bounding the farm in any part? If there should, it ought to be taken into consideration, as the same is a very important addendum for the convenience of carting manure, lime, and marketing. Thus it will be seen that, although a central situation is desirable, it is frequently necessary to sacrifice the same in order to secure other important advantages.

There are also some other minor points which ought to be attended to when the situation is fixed upon and the levels admit of them, and these are—can you arrange your barn so that the ground where the sheaf-hole is situate for getting in the corn may be pretty near the level of its sill, thus affording an important advantage in the getting in of the unthreshed corn? Another, of the same character, is with respect to the getting in of the turnips. Another is the laying down of a pipe-conduit from tanks in yards to some convenient distance from the buildings according as the levels of the situation allow of it, where the urine-water might be let off by a tap direct into the urine-cart, thus saving an immense deal of trouble in the pumping of the same. These are, although minor points, important adjuncts to the economising of labour about a farmstead, and should not by any means, where practicable, be lost sight of.

The foregoing seem to me to be the principal considerations which ought to be a guide in the selection of a proper situation, also in making the best of one when selected, where it is proposed to rear an entire new set of buildings.

I will now consider, in the next place, the arrangement of the farm buildings. In laying out the different farm-buildings applicable to a mixed system of tillage and the feeding of live stock in houses, as practised in this country, I have endeavoured to get them into as small and convenient a space as the quantity of buildings required admitted of, also to provide for the buildings, particularly for the fold-yards, a good southern aspect, and the very great acquisition of convenient foddering and littering without going out into the open yard from the straw-barn to the different beast-houses, sheds, and stables.

In order to get a clearer idea of the general arrangement of the farm-buildings, as to the advantages which the situation of each class of buildings possesses, I will consider them more minutely with respect to their several good properties, beginning with the

barn, including straw-barn, as being the focus from which the principal part of the fodder is obtained. In fixing upon the situation of the straw-barn, I was anxious to get the same as near the centre of the buildings as possible, and also to get a communication at both sides with it. This led me to the projecting it out at right angles with the beast-houses on the east side and sheds on the west. After considering the disposition of the barn so placed over, I think it is much superior to the more general mode of placing same; for, in the first place, it gives an opportunity of attaching the necessary buildings, at the north or east side, for the use of water or any other power that may be applied, without at all interfering with the other arrangements. Further, in thus getting the centre place for the straw-barn, I gained what I was most anxious to secure, a communication on both sides, that on the east side with beast-houses, milching cow-house, sheds, and on the west side with large shed, cart-horse stable, and hack-horse stable, thus acquiring a very important acquisition with respect to the convenient foddering and littering of these several houses. There is also in the position of the barn so placed every convenience for getting in the unthreshed corn, either by having a sheaf-hole at the north or west side of same. On the east side of the barn I have laid out the necessary buildings for a steam-engine. This of course is only presumed, the situation being quite as applicable for the fitting up of any other power that might be determined upon. In connexion with the barn, by stone steps, is the granary, situate over large open shed and turnip-house. Over the latter house is a trap-door, shown in the section of the line A B on the plan. Thus every facility is afforded for the quick transport of the grain from the barn to the granary without going out into the yard, and afterwards in loading it for the market, or getting same for home consumption. The preferability of having the granary over an open shed, in order that the corn may be kept perfectly dry and free from that damp and moist state in which the same is if placed over a stable or other occupied house, ought to be more generally known in order that the practice which is at present too prevalent may be abandoned at once.

I will now direct attention to the double-stalled beast-house adjoining the straw-barn on the east side, which will be found a great acquisition to a farmstead in thus getting so large a quantity as forty head of cattle into one house. Also by the proposed arrangement of having a passage down the middle of the house, the time occupied in foddering and littering such a large quantity of cattle will be much less than if the same were in one continuous range.

At the extreme end of the beast-house are the turnip and hay-houses, and I propose that a wood tramway for a small waggon to

run on be laid from the straw-barn down the middle of the beast-house, and right in betwixt these two houses, as shown on the ground-plan, so that the turnips might be loaded on to the waggon and run down all the way betwixt the cattle. To this waggon might be attached a turnip-cutter, in order that each beast's portion of turnips might be cut and given direct. The hay-house, when not in use, might be very properly applied for the storing a large quantity of turnips. Adjoining this last mentioned house, but projecting at right angles with it, is the boiling-house for the preparing of the different kinds of food used in the feeding of the fat cattle and other live stock, the same being in immediate communication with the beast houses and sheds. Proceeding down this range of buildings will be found milching cow-house, loose-house (or this house might be used as a hay-house when the hay-house spoken of before was in use for storing turnips), bull-house, and calf-house. It being desirable that the milching cow-house and calf-house should be as near the dwelling-house as possible, I have endeavoured in this arrangement so to place them, supposing dwelling-house to stand on the south side of the buildings. The beast-sheds and fold-yards projecting at right angles, with double-stalled beast-house, with a passage at the back of same, thus continuing the communication with the straw-barn as well as boiling-house, and capable of holding two fat beasts each, are particularly well situated in respect to enjoying a good aspect, the sun and air in winter having free access from the south, while at the same time they are protected from the cold northern blasts by the range of buildings situate on that side. At the end of these sheds is a turnip-house for the use of same. Adjoining this turnip-house, on the east side, are three piggeries, which are of rather peculiar construction, the doors opening into same answering two purposes, the one a protection from the outside, or betwixt one piggery and the other; the second purpose the confining the pigs in the house if required by closing the door against the entry into such covered part; also when the same wants cleaning out, it can be done without the pigs being let out into the yard. The same are in close proximity to the dwelling-house for the convenience of feeding. At the back of the piggeries is the servants' privy, which is a very necessary appendage about a farmstead in preserving cleanliness. Within the square formed by the buildings previously referred to is the manure-yard for the convenient littering out of double-stalled beast house, milching cow-house, calf-house, and piggeries. At the north-east corner of this manure-yard I propose that a tank should be sunk about 8 feet into the ground for the drainage of the urine from these several buildings as well as sheds. I may here observe that I consider it necessary that there should be two tanks in this

arrangement, for it is important that urine-drains should have very short runs, otherwise they are very liable to get stopped up, every other precaution being likewise taken. The buildings on the west side of the straw-barn I will now consider, and the first is the large shed with fold-yard which I have laid out as very suitable for the folding of young cattle. There is a passage at the back of this shed, in order that the communication from the straw-barn may be continued to cart-horse stables, hack-horse stables, as well as for the convenient foddering of the cattle in this shed. At the south-east corner of the fold-yard is another tank for draining the stables and yards. Adjoining the shed is a turnip-house for the use of same; or, in case the young cattle did not require turnips, this house might be very useful for storing a quantity of straw for the use of farm horses, which could be brought direct from the machine when threshing; over these two last-mentioned houses is the granary. Adjoining the turnip-house, on its south side, is the range of cart-horse stables with a hay-house at the further end: thus it will be seen that, so far as the foddering of the horses either with straw from barn or hay from hay-house, ample convenience is provided; also by the passage in the middle of the stable into a large fold-yard, the littering out is easily accomplished, and it is desirable that the litter from horses should be picked and well trod about by young cattle. There is adjoining the hay-house, on the west side, a hack-horse stable for two horses, with harness-room attached, which, communicating with the hay-house, as well as with the straw-barn, can also be conveniently littered out into the large fold-yard. Adjoining the turnip-house, on its west side, is the implement house for preserving and keeping dry the different agricultural implements when not in use. Adjoining same, and presumed to open into a small paddock, is a loose box for the use of a mare and foal, or as an hospital for either horse or beast that may be unwell, thus keeping the same away from the other cattle. This terminates the buildings in a westerly direction, but another range projects here at right angles, with loose box, and contains a house for the storing and mixing of the different artificial manures which may be used; a shed for the sheltering of the waggons and carts; a blacksmith's shop, which I think is desirable on a farm of the extent of 300 acres; and at the extreme end of this range is the gig-house which terminates our review of the buildings.

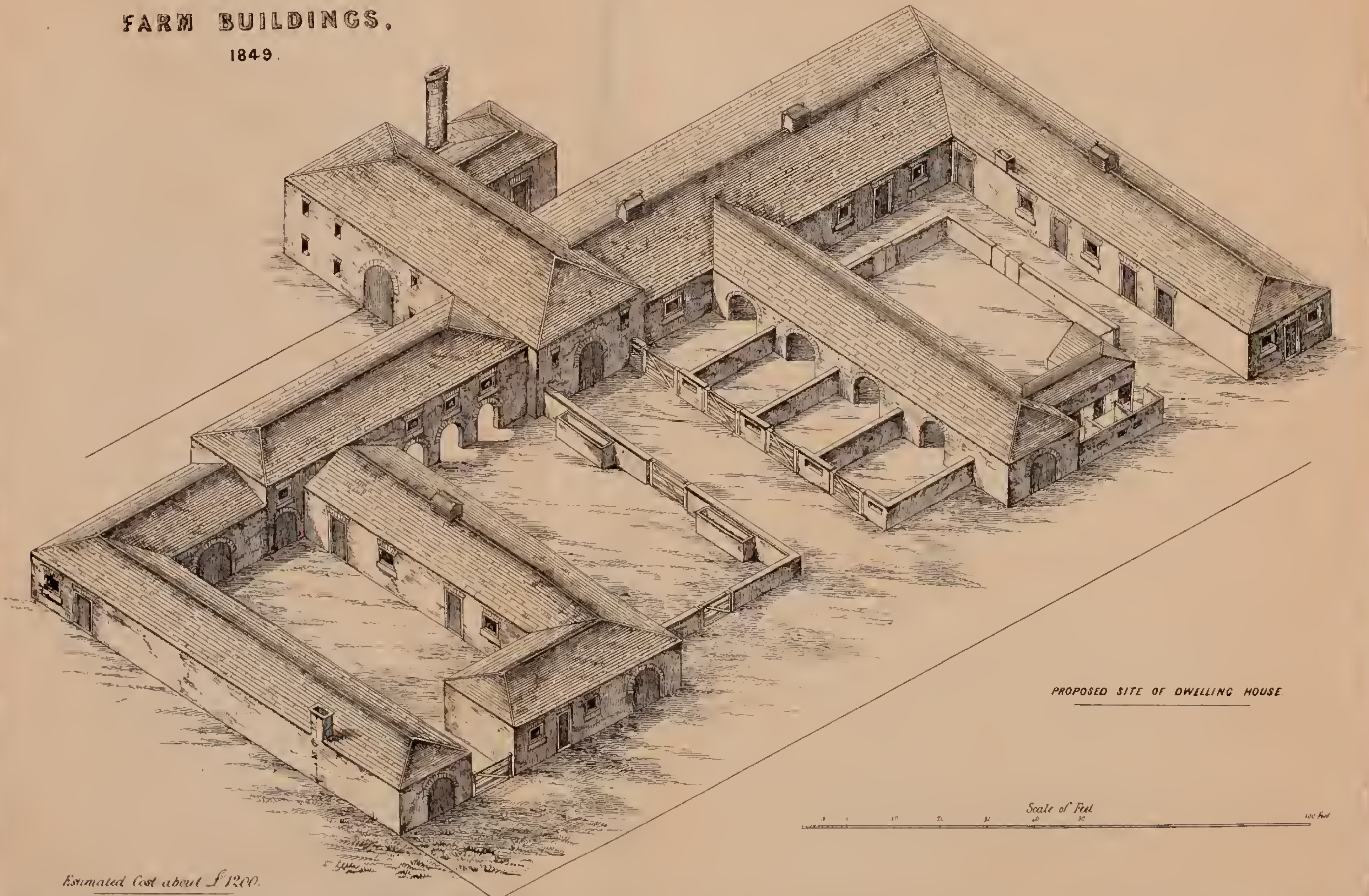
I will now offer a few remarks on the construction of the buildings. It is a true saying, "what is worth doing at all is worth doing well:" therefore I should advise that the very best materials of every kind be used, the nature and character of the country proposed to be built in admitted of. In the specification attached I have considered the buildings to be of brick, but the locality will

point out what description of materials are to be used, whether brick or stone. It does not often happen that both can be had at the same expense, but rather on the contrary: when bricks are plentiful, stone is scarce, and *vice versâ*. The whole of the woodwork to be of the best Memel, excepting for granary flooring and boarding for stable, stalls, and beast stalls; the former to be of red pine, and the latter English larch. As to the covering of the different buildings, I consider the Welsh slate to be a good cover, and to be had at a reasonable cost. In the drawings attached I have taken the two centre range of buildings to be covered with tiles; this of course is quite a matter of taste, and quite optional. The widths and heights given to the several buildings in the drawings are the same as what has been generally given to buildings of like character with which I have had to do, excepting for barn and double-stalled beast house. As to the latter, the cause of the extra width, and for what purpose, will be fully understood from what has been before said; and as to the former, the extra width given to the barn will be found very useful and convenient not only for holding a larger quantity of unthreshed corn, but also a larger quantity of straw. I may observe that I never heard a farmer complain of his barn being too wide, but, on the contrary, very frequently of its being too narrow. There are two or three other minor points with respect to the construction I will point out, and the first is the ventilation of the cart-horse stables and beast-houses. The old system of having openings just behind the horses or beasts I consider defective and objectionable, as far as the perfect ventilation of the building is considered, for these separate reasons: the effluvia and impure air arising from the cattle ascending by their lightness to the top of the building, there they remain, and are unable to make their escape, it being impossible to get to the openings provided, for there the cold air is rushing in. The other reason is, that the current of cold air, according to the old mode, is directed right over the backs of the animals, and is thus liable to give them cold. The plan I advocate is a ventilator (or what is commonly called louver boarding) to be put at the top of roof and doing away with the openings. This mode will allow free egress to the impure air, as well as do away with all draughts, while at the same time there will be sufficient air admitted from the doors and windows for the perfect ventilation of the building. Another point is the preventing of the effluvia from rising from the urine-drains. Instead of the ordinary perforated grate for the stables and beast-houses, I should advise the placing of a small stench trap which effectually prevents its rising, and in the placing of same for the better prevention of the drains from stopping up, is to put them in a side channel as shown on ground plan: for on sweeping out the dung,

PERSPECTIVE VIEW OF

FARM BUILDINGS,

1849.

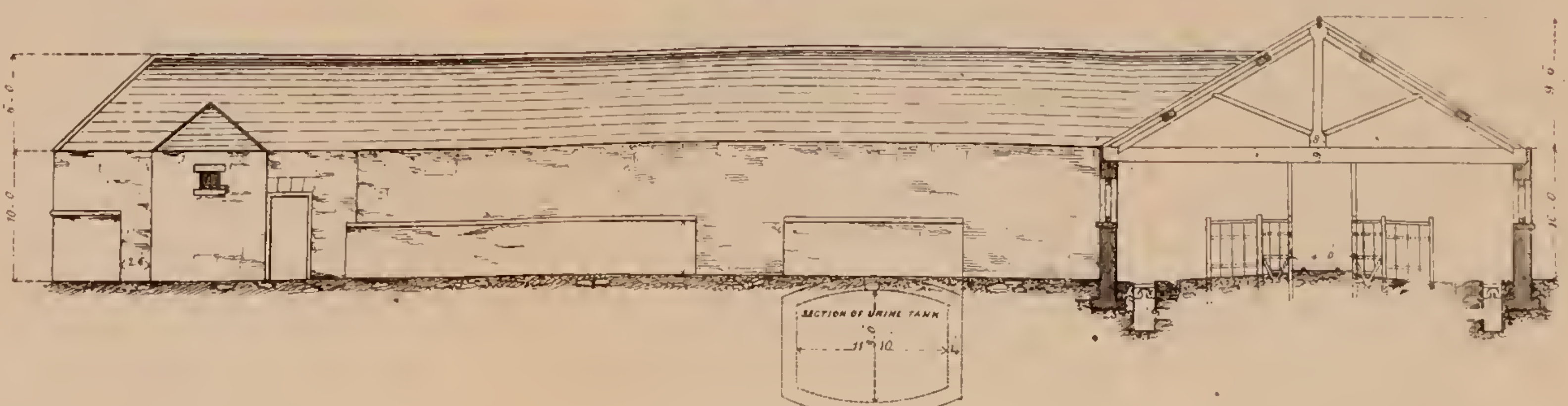


Estimated Cost about £1200.

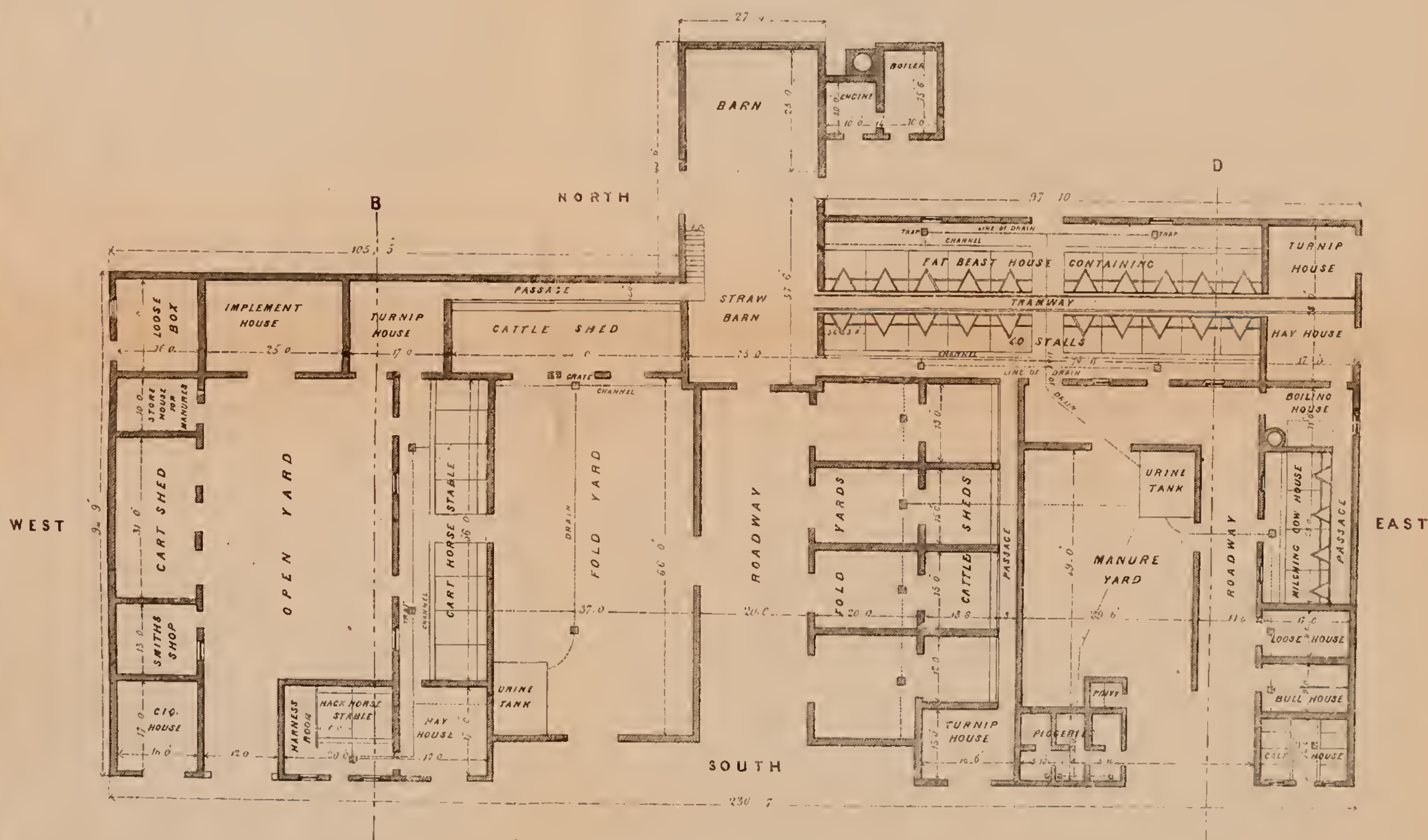
Thomas Sturgess Surveyor Bedale

Standidge & Co Litho Old Jewry

FARM BUILDINGS,
1849.



SECTION THROUGH C.D



A GROUND PLAN. C

Scale of Feet

10 5 0 10 20 30 40 50 100 Feet

SECTION THROUGH A.B

Scale to Sections.

10 5 0 10 20 30 40 Feet

Thomas Sturgess Surveyor Bedale

Standidge & Co Litho Old Jewry London

the same would not be drawn over grate, thus preventing any from getting in, while the urine would run down those side channels into the grate. Another precaution would be the sinking of a cesspool under each grate for the urine to drop into, where any sediment would be left, the same being very easily cleaned out by removing grate. These precautions, if properly attended to, would entirely do away with the inconvenience which is so frequently experienced by the drains stopping up.

I have, therefore, gone carefully over the selection of a situation, the arrangement and character of the construction of a full set of farm buildings, but at the same time perhaps it may be thought by some that the buildings are too extensive for a farm of the extent under consideration, but I consider that, with the exception of beast-houses and beast-sheds, the other conveniences are no more than what are at present generally attached to farms of the extent. Now a few words in conclusion, on the justification of so large a proportion of beast-houses and beast-sheds.

The necessity of increasing the productive powers of the soil by the application of the very richest manures is forcing itself more and more every day upon the attention of the practical farmer, so that he may be able to bear the increased burdens of taxation, as well as in some measure to be able to compete with the foreign corn brought to this market. In order therefore to effect this point, it is necessary that, in addition to the regular consumption of the straw and other fodder, there be used some richer artificial substance to mix with same, to improve its fertilising qualities. The most improved mode is the feeding of cattle in houses by the use of prepared food (linseed boiled, mixed with meal and chaff), in conjunction with turnips, the merits of which system have been ably set forth in a Number of the Yorkshire Agricultural Society's Journal by Mr. Marshall. Now, although I am not prepared to assert that at all times the beasts themselves will leave a profit by this mode of feeding, yet I can affirm that they will at all times pay for the expense attending such method. The expenses then being returned, I consider the enriched condition of the manure will be a source of ample profit, as it can be testified to the fact by many farmers, that the effects upon the produce have been astonishing by a dressing of this improved manure; therefore it becomes a matter of apparent importance that a farmer should have the necessary buildings attached suitable to this mode of feeding; and I think that a farmer farming 300 acres, which, say, is two-thirds in tillage, ought to feed in houses sixty head of cattle, so that his manure may be of such a quality as to be able to enrich so large a breadth of tillage. This subject, when well considered over, will, I think, convince every unprejudiced person

that the extent of beast-houses in this plan is not greater than what is really requisite, and what the practical farmer requires.

February 13, 1849.

N.B. In the drawings I have (instead of giving separate elevations of every front) combined the whole in a perspective view, which I think will give a better idea of the arrangement than could be obtained by separate drawings; and I have found that workmen, after examining a drawing of that kind, have been enabled at once to comprehend the character and arrangement of the buildings intended being built.

SPECIFICATION and Particulars of certain Artificers' Work required to be done in erecting and completing, fit for use and occupation, a certain Farmstead, situate , for , agreeably to Plans, Elevations, and Sections hereunto appended, and to the satisfaction of , his surveyor.

EXCAVATOR.

To excavate the ground to the proper levels, and as may be found requisite for the construction of the foundations, the urine-tanks, the drains from buildings to tanks, the cesspools, and all other works for which the ground will be required to be excavated. To fill in again and level about the foundations, after the brickwork has been executed, the ground so dug out.

BRICKLAYER.

To build up all walls to the several heights and thicknesses as shown and figured upon the Plan, and which may be also requisite to render the whole of the buildings and premises complete and perfect in every respect: the same to be executed in the most careful and workmanlike manner. The whole of the external brickwork to be finished with a neat struck joint. Turn 1½-brick arch to urine-tanks, and the whole of the brickwork for same to be laid in cement. Turn 1½-brick arches to all windows, barn-doors, turnip-house doors, hay-house doors, stable, and cow-house doors. Build all proper drains from stables, fold-yards, and beast-houses to urine-tanks. To bed in mortar all the plates, lintels, templets, stonework, and other work intended to be set in the brickwork, and so requiring. To back up with solid brickwork all stone and iron work intended to be set in the same. The bricks to be hard burnt, and approved of by the surveyor. The mortar to be compounded of strong lime and sharp sand, mixed in the proportion of one-third lime to two-thirds sand, well tempered and beaten together. The walls to be well flushed up with mortar to keep out wet.

MASON.

Provide and fix to barn, turnip-houses, hay-houses, implement-house, straw-barn, and gig-house doors, stone blocks 14 inches square by 6 inches deep, properly morticed for receiving crooks to hang doors on. Provide and fix stone blocks 6 inches square by 4 inches deep, morticed for receiving bolts to fasten same. Provide and fix to all the other doors solid Yorkshire-stone sills, 9 in. × 2¼ in., properly morticed for receiving the ends of the door-posts. Provide and fix solid Yorkshire-stone sills to all the windows, 9 in. × 2¼ in. Provide and fix stone steps from barn into granary, 12 in. × 6 in. Provide and fix ridge-stone to all the buildings, 9 in. × 6 in.; also coping to all the fold-yard walls, 15 in. × 2 in. Provide and fix blocks of stone 9 in. square by 6 in. deep, properly morticed

to receive posts of stable-stalls. Provide and fix stone blocks 12 in. square by 4 in. deep, properly cut out to receive grates and stench-traps. Provide and set in mortar flags to form turnip-cribs in beast-houses and beast-sheds where directed. Provide and lay down stone curbs along beast-houses 3 in. × 6 in., leaving a drop of 3 inches. And provide all stones and execute all paving which may be required for beast-houses, beast-sheds, stables, and yards, and which may be required to render the buildings complete. Cut out of the stonework, when required for plumbers and other workmen. Attend on the several trades, and leave all complete at the finish.

Slater and Tiler.

The slated roofs, where shown on the plans, to be covered with Duchess slating, on laths laid with a proper lap, and secured with 2 strong copper nails to each slate: the whole left perfectly water-tight at completion. The tile-roofs, where shown on the plan, to be covered with pantiles on laths laid with a proper lap: the whole to be well pointed and left perfectly water-tight at the completion of the building.

Plasterer.

To plaster with lime and hair the whole of the inside of the corn-granary, and the walls to be flushed up with mortar to rafters to keep out rats. Also one coat of plaster to be given to hack-horse stable and harness-room.

Carpenter and Joiner.

The whole of the timber used to be of the best Memel, except where otherwise directed.

Floors and Roofs.

To be framed in the best manner with the following scantlings of timber. The granary-floor over shed, and turnip-house, with corn-floor in barn, to have girders 12 in. × 12 in., with corn plates 7 in. × $1\frac{1}{2}$ in., and joists 9 in. × 3 in. Lay 1-inch red-pine flooring, properly ploughed and tongued, with sheet-iron girting $\frac{3}{4}$-inch wide:—

Schedule of Scantlings to the Roofs.

	In. × In.		In. × In.
Tie Beam	7 × 4	Ridge and Wall Plates	5 × $1\frac{1}{2}$
King Post	8 × 3	Hips	10 × 2
Principal Rafters	7 × 3	Angle Ties and Dragging pieces	5 × 4
Common Rafters	$3\frac{1}{2}$ × $2\frac{1}{4}$		

Scantlings of the timber to barn and double-stalled beast-house:—

	In. × In.
Tie Beam	9 × 4
Principal Rafters	9 × 3
Common Rafters	4 × $2\frac{1}{4}$

N.B.—The remainder of the timbers to these roofs to be of the same scantlings as given for the other buildings.

The roofs to be framed as shown upon the plans, and the tie-beams to be fastened to king-posts with $\frac{3}{4}$-inch wrought-iron bolts. The whole of the roofs to be lathed with $1\frac{1}{2}$-in. × $\frac{3}{4}$-inch laths to receive the tiles and slates.

The woodwork to the doors, windows, and fittings to stables and beast-houses, to be of the following scantlings:—

	In.		In.
Door Posts and Heads	5	×	4
Window-frames	4	×	3
Post to Stable Stalls	4	×	6
Top Rail ditto	4	×	6
Side Rails ditto	7	×	$1\frac{1}{4}$
Boarding to ditto to be of larch, and to be $1\frac{1}{4}$-inch thick.			
Rail for Hay-rack, top and bottom	3	×	$2\frac{1}{4}$

	In.		In.
Rail for Manger-boarding . .	2	×	2
Boarding to ditto front . .			$1\frac{1}{4}$
Boarding to ditto back . .			1
Posts to Beast-stalls	5	×	5
Posts for Railing-off Gangways	5	×	5
Rails to same	4	×	3
Boarding to Beast-stalls to be of larch, and 1 inch thick.			

The doors to the different houses to be $1\frac{1}{4}$-inch ledged doors, excepting the two doors into double-stalled beast-house on the south side, which is to be lathed or trellised for the purpose of better ventilation. The windows to have slides of 1-inch thickness each, and the windows to the stables to have 4 squares of glass at the top of same. The stalls to stables to be of the length and heights figured upon the plan, and to attach manger and stour rack to same. To post and rail-off the different gangways shown on the plan, and to fix triangular straw-racks to beast-houses between each beast, so as to form a division, as shown upon the ground-plan; and to the sheds a rack all the way along with the gangways. To put to the beast-houses and stables ventilators or louver-boarding for the purposes of ventilation. To provide all proper latches and hinges to the several doors, as well as all locks that may be required; the same to be approved of by the surveyor before fixed.

Plumber.

To line the vallies with milled-lead, 5 lbs. to the foot superficial. Put 5 lb. milled-lead flashing, 8 inches wide, where required, and to be properly secured. To provide the requisite cast-iron spouting for the several buildings; the pattern of same to be approved of by the surveyor before fixed.

Glazier.

Put to the top of stable and granary windows 4 squares of the best second Newcastle crown-glass, well puttied, and left whole at the finish.

Contractor.

To provide all hoarding, scaffolding, and shoring that may be required in the construction of the buildings; to pay all cartage of materials, as well as every contingent expense incidental to the full completion of the several works, shown, contained, described, or implied by the drawings or this Specification. All work to be executed in the best, most sound, and workmanlike and judicious manner, with the best materials of every sort and kind. All brick, stone, or other work, to be pointed up and made good at the finish of the contract. No extras to be allowed, unless a written order is obtained of the surveyor; and all such extras or omissions to be added to or deducted from the amount of the contract according to and after an admeasurement to be made at the conclusion of the work. The whole of the work to be done under the direction and to the full and complete satisfaction of   , surveyor; and no alteration, or addition, or deduction in the buildings or premises shall in anyway vitiate or supersede this contract, but shall be added to or deducted from the amount of the same. That previous to   being called upon by the contractor for advances of monies on account of works performed under this contract, it is required that the contractor do first obtain a certificate from the surveyor certifying to the amount and quantity of work performed; and the said certificate being obtained, the amount, less 15 per cent., which is to

be retained as a guarantee for the due performance of the contract, to be paid within ten days after the production of the certificate. The balance due to the contractor after the completion of the several works to be paid within two months after the date of the surveyor's certificate, certifying the full and complete performance of the several works hereinbefore referred to.

Witness the hands of the parties.

Abstract of the Prices of the Artificers' Work.

Excavating ground for urine-tanks, 4*d.* per cubic yard.
,, ,, drains and foundations, 3*d.* per rod.
9-inch brick-walling, 4*s.* 6*d.* per square yard.
14-inch brick-walling, 5*s.* 6*d.* per square yard.
14-inch brick-walling to tanks, laid in cement, 8*s.* 6*d.* per square yard.
Rubble-walling, 10*d.* per square yard, labour only (18 inches thick).
Roofing to barn and double-stalled beast-house, 2*l.* 2*s.* per square.
,, the other buildings, 1*l.* 17*s.* 6*d.* per square.
Pantiling, 1*l.* per square.
Slating, 1*l.* 2*s.* per square.
Ridge-stone, 1*s.* 6*d.* per yard run.
Fold-yard wall-coping, 1*s.* 10*d.* per yard run.
Granary flooring (red pine), 2*l.* 4*s.* per square.
Barn doors, turnip-house doors, hay and gig-house doors, 1*s.* per square foot.
Stable doors, cow and calf-house doors, 7 ft. × 4 ft., at 26*s.* each.
Windows to stables, including glass, 10*s.* 6*d.* each.
Windows to beast-houses, without glass, 8*s.* each.
Fittings to stables, stall, manger, and stour-rack, at 2*l.* 8*s.* per stall.
,, beast-houses, 1*l.* each stall.
,, beast-sheds, 4*s.* 6*d.* per yard run.
Gates to fold-yards, 10*s.* 6*d.* each.
Ventilators, 3 ft. × 2 ft., 7*s.* 6*d.* each.
Flagging for barn, &c., 2*s.* 6*d.* per square yard.
Stone sills to windows and doors, 8*d.* per foot run.
Stone steps into granary, 8*d.* per foot run.
Curbstone to beast-houses, 3*d.* per yard run.
Flag-cribs to beast-houses, 5*s.* each.
Paving, 5*d.* per square yard.
Plastering to granary, 6*d.* per square yard.
Lead for vallies and flashings, 30*s.* per cwt.
Cast-metal spouting, 4 in. wide, 2 in. deep, 1*s.* 4*d.* per yard.
Stench-traps, 6*s.* each.
Common perforated grate, 2*s.* each.
Boiler for boiling-house, at 8*d.* the gallon.
Thrashing-machine worked by horses, with chaff-cutter attached, cost about 55*l.*
A six-horse power steam-engine, with thrashing-machine, chaff-cutter, pair of stones to grind coarse meal attached, cost about 250*l.*

N.B.—The above prices are for labour and materials only, and what has been paid in this part of the country. Different localities will alter many of the prices. In an estimate of the expense the cartage will have to be added.

XIX.—*On the Construction of Farm-Buildings.* By C. P. Tebbutt.

That the best principle upon which farm-buildings can be constructed should be generally known and reduced to practice, is a matter of the greatest importance in agriculture. The great outlay of capital necessarily involved in their construction, their durability when finished, and consequently the difficulty of remedying mistakes without incurring great additional expense, are considerations which point out this question as one most suitable to be discussed in the pages of an agricultural journal; and the many cases in which large sums of money are expended in building farm-homesteads, substantial indeed in their character, but without proper arrangement, and often in inconvenient situations, show us that there is no subject upon which information is more generally needed.

To try to lay down one cut-and-dried plan of farm-buildings, as applicable to farms of all descriptions and in various situations, would be an absurd attempt. There are many local circumstances connected with every farm, which require attention and which can never be provided for by any general plan, however good in itself. Thus on a farm where a large proportion of the arable land is yearly sown with spring-corn, which is usually threshed with the flail, a large amount of barn-room will be required. On the other hand, on a farm where wheat alone is grown, which is usually threshed with a machine, a proportionally smaller amount will be required. And again, the materials of which the homestead can be best made, differ very widely in different places. Brick and slate, stone and tile, and even wood and thatch may all have their appropriate locality, and the person who should recommend the use of any of these in all cases, to the exclusion of the others, would be rather showing his own ignorance and presumption than informing the agricultural community.

The best course to be taken, I think, will be to endeavour to lay down some principles which may be generally acted upon, and to give an illustration of them by a plan of farm-buildings in which they are embodied, leaving it to each reader to carry out those principles as may best suit his individual case.

The purposes for which the farm-homestead is required, admit of two great general divisions. In the first place it is wanted as a manufactory for the manure required to sustain fertility, and in the second as a building containing conveniences for carrying on much of the general business of the farm, such as threshing and dressing the corn, storing food for cattle, providing shelter for the

horses when their work is done, and other minor purposes which need not be named.

Thus then all plans for farm-buildings should be so arranged that the manure may be made in the best possible way and at the least possible cost, and that the general arrangements of the buildings required for the other purposes that have been named, may be such that they should answer those purposes with the smallest expenditure of labour and with the greatest efficiency.

While, however, it is very important that both these two great general requirements should be fulfilled, and I hope to show that they may both be fulfilled, there is great difference in their relative importance. Although it is bad indeed to see homesteads with barn and granary, stable and chaff-house scattered and separated, the inconvenience and loss is but small when compared to that sustained in the homestead, where the yards for feeding cattle, and protecting horses and growing stock, are cold and ill-arranged, exposed to the cutting blasts of the north and east, and perhaps at the same time shut out by high buildings from the mid-day sun, which renders mild for a time even the air of December and January. In the former case a certain wasteful expenditure of labour is caused, which is of course to be blamed; but in the latter case the evil is very great and difficult to estimate, causing often the difference between a yard of stock "doing well" and "doing badly."

The first great consideration then in erecting farm-buildings is, that the yards where the cattle are sheltered and the manure manufactured, should be *all* of them in the *best possible position* for answering the purposes for which they are required. What is the most favourable position for a straw-yard? It should be of convenient size, small for feeding cattle, somewhat larger for growing stock, *invariably* well sheltered with a wide shed or hovel on the north, or a point or two to the north-east, also somewhat sheltered to the east and west, and sufficiently open to the south to admit the benefit of the warmth of the sun's rays during the short winter-days when the cattle are usually in straw-yards. The only way in which all these advantages can be gained for all the cattle-yards is to place them side by side, so that all are alike in situation, with a long shed running along the north side, a low wall forming the southern boundary, the same for the division of the yards, and sheds, or at least buildings equal in height to sheds, to the east and west. But by placing the yards in this position every advantage may be obtained, and I think every farmer comparing yards thus placed, with the common practice of making four yards which constitute parts of a square, surrounded with buildings, two of the yards necessarily unsheltered on the north

side, and often shut out from the sun, will at once perceive the superiority of the plan proposed.

The manure-manufactory of the farm being thus provided for by a line of yards, four, six, or eight in number, with a wide shed running along their north side, the consideration of the position of the other parts of the homestead will follow; and having regard to economy, convenience, and compactness, there is no better plan than to arrange them side by side along the northern wall of the cattle-yards. The position of the barn, as the place from which much of the litter for the cattle-yards must proceed, claims the first notice. It should be nearly central, containing one or two threshing-floors, as circumstances may require, and having the large doors towards the north, and small doors in the south wall for the convenient delivery of straw into the yards. On the one side of the barn may follow the chaff-house, stable, &c., and on the other the granary, cart-shed, &c. On the east and west wings of the straw-yards, running in a southerly direction from the buildings just described, may be placed either loose boxes for feeding cattle, or sheds for tying them up, or, if neither are wanted, high blank walls to shelter the yards on the east and west. In the arrangement of the yards, the horse-yard will of course be placed near the stable, and the size of the other yards may be varied according to the purposes for which they are required, it being only provided that all are well sheltered.

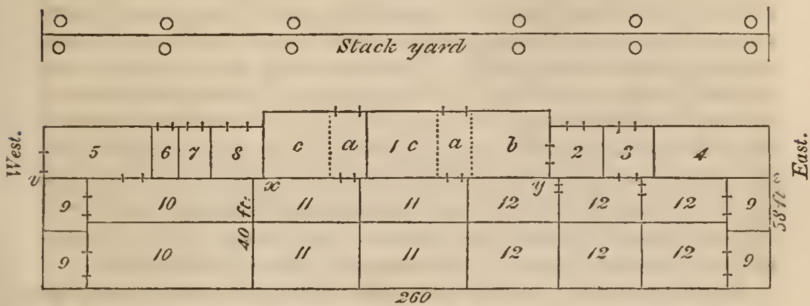
The general effect of these arrangements will be that, instead of the farm-homestead forming, as is commonly the case, a square, divided into yards and surrounded with sheds and various buildings, it will form an oblong, containing on the south side the yards for feeding cattle and manufacturing manure, and on the north the various buildings required for the general business of the farm.

Having thus given a brief sketch of the plan which is proposed to be followed in the construction of farm-buildings, in order more fully to illustrate it I shall proceed to describe somewhat in detail a plan of a homestead, suited to a farm of 250 acres, say 200 arable and 50 pasture, and which would, I believe, be "erected at a reasonable cost and be adapted to the wants of a practical farmer."

Although I have placed the cattle-yards as first in importance, I will, for convenience sake, commence with the barn, the largest of the buildings belonging to the homestead, and which is numbered 1 in the annexed plan. Upon an ordinary arable farm of the size we have supposed, a barn sufficiently large to contain two threshing floors will be required. And even at the outset objections may be made to this proposition by those who advocate the use of the threshing-machine to the exclusion of the flail. Large farms in Scotland, it will be said, are managed with only

one barn, and the sound of the flail is never heard in the homestead. But in England the maltster refuses to buy barley which has been threshed by a machine; the seed-merchant prefers oats which have been threshed by hand; the expense of threshing beans and peas by machinery is generally greater than by the

North.



South.

flail; and the farmer prefers giving the straw of his spring corn to his cattle, day by day, fresh from the barn. A moderate amount of barn room must, therefore, be considered as necessary in every well arranged homestead. The size of the barn proposed is 100 feet in length by 25 feet in breadth, and divided into two compartments; one, 60 feet in length, and the other 40 feet. In each of these will be a threshing floor, marked in the plan *a*; and it will be found convenient in the larger compartment to have the space between the threshing floor and the east end of the barn boarded, in order that room may be obtained for dressing wheat when threshed in large quantities by the machine.

This space is marked *b* in the plan, and forms part of the eastern compartment of the barn, which should always be used for the purpose alluded to. The two spaces marked *c*, called "mows" in this locality, may be floored with concrete, consisting of small sifted gravel stones mixed with a small proportion of lime and water—a composition which, if laid down about 8 inches thick, and allowed three months to dry, will form a far cheaper and more lasting floor than the common brick. On the north side of the threshing floors will be placed the customary large doors for taking in corn; and on the south, smaller doors for the delivery of straw into the yards. The height of the barn may be about 15 feet from the set-off of the foundation; and, as it is usual to fill the mows with corn completely to the top, the roof should be boarded before slate is put on, to prevent injury to the slate from the forks of the men when taking in corn. Next to the barn on the east may be placed a small granary, marked 2

on the plan, which is 18 feet in width by 20 feet in length, and has a door into the barn; so that, when necessary, corn which is dressed may, with little trouble, be removed into it. The granary of course must have a boarded floor, and may be fitted up with bins according to fancy. The height in the walls may be 8½ feet. Next to this follows a place 18 feet square, marked 3, which is required to contain the food for cattle, whether oil-cakes, linseed, composition, or corn, and having a door into the cattle-yards, and also one towards the north. The cart-shed, 42 feet long, and marked in the plan No. 4, will finish the range of buildings to the east. It will be open to the north, so that the hot summer sun will not injure the carts, and being 18 feet in width will, beside holding the carts, afford sufficient room to shelter various implements, such as harrows, ploughs, &c., which may be placed behind the carts; care, of course, being taken that they are secured from injury when the carts are backed into the shed.

Again, returning to the barn, the building adjoining it at the west end, No. 8, 20 feet in length by 18 feet in width, will be required as a tool place, in which all the smaller class of implements, such as forks, hoes, spades, &c., may be safely kept; and it will also, if necessary, serve as a place where a drill may be secured under lock and key. Next to this, at the west end, will be a small place, No. 7, 12 ft. by 18 ft., which should be used for cutting chaff for the horses, whether by manual or by horse power. The chaff-house itself, No. 6, will, of course follow; and the size proposed, 18 ft. by 10 ft., will be found amply sufficient. The separation between this place and the last-mentioned should contain a large window in the upper part, so that the chaff, when cut and measured, may be emptied into the chaff-house with the smallest possible amount of labour. That very important part of the farm homestead, the working-horse stable, marked No. 5, next claims our attention. If constructed for 10 horses, the number which will probably be required to work a farm containing 200 acres of arable land, the length of the stable should be 40 feet, and, according to the proposed plan, it will be 18 feet in width. This will, to some persons, appear large, but I think there is no mistake more common than to build farm stables too narrow; more especially when the harness is hung on pegs in the stable behind the horses. The use of a harness-house separated from the stable is advocated by some, and where the stable is already built, and perhaps does not exceed 15 feet in width, the harness-house may be a useful adjunct; but it is, I think, better at once to make the stable of such a width that sufficient room will be provided for the harness of each horse to be hung on a pin driven into the wall behind his usual situation in the stable without crowding or inconvenience. There should be two doors

into the stable, one in the west end, and placed as nearly as convenient to the southern wall, and one opening into the horse-yard at a little distance from the east end of the stable. The manger and rack should be affixed to the northern wall, and by this arrangement the keen blasts of the north and east will be as far as possible excluded, a point in winter of no small consequence. The floor of the stable is too often laid with a very rapid incline from underneath the manger to the gutter which carries off the drainage of the stable, but attention has lately been drawn to the impolicy of this practice, and in future it is recommended that no greater incline be made than is absolutely necessary; and if the floor be carefully laid this will be found to be but very slight. The proposed height for the stable and all the buildings that have been described since the barn, is $8\frac{1}{2}$ feet from the set off, a height which, though sufficient, will not, I think, be found too great. I may also here remark what I have I find omitted, that the floors of the oil-cake place, of the chaff-cutting place, of the chaff-house, and the tool-place, may be all advantageously made of the concrete to which I have before alluded.

Before describing the yards, it may be well to allude to the buildings proceeding in a southerly direction from the principal range marked No. 9, and forming the east and west wings of the homestead. They are 40 feet in length by 15 feet in width, floored with concrete, and each equally divided into two compartments with doors into the yards. It is proposed that they should be used as loose boxes for feeding cattle, and if two be allowed to each box, room will be afforded for eight cattle, which may be placed here for their concluding three months before going to market. I am aware that much difference of opinion prevails as to this matter, but am most decidedly of opinion that when in a loose box, with a moderate degree of warmth, and perfect shelter from the inclemency of the weather, a bullock is in the most favourable possible position for the production of beef. Among those, however, who do not think with me, these buildings may be used for other purposes, for instance, as sheds where cattle may be tied up, or as pigsties. My object is to show that the *general arrangement* proposed is the most convenient possible, rather than to pertinaciously insist upon any single point of detail.

Having thus, by the erection of the buildings described, obtained a large oblong court, having three sides enclosed and open to the south, the next consideration will be the division of the yards, and the provision of a convenient amount of shelter for each of them. And in the plan proposed advantage is taken of the southern wall of the long range of buildings already described, to

form the back of the shed, which is 15 feet in width, extends the whole length of the range, and at once provides shelter for all the yards. That part of this shed which adjoins the barn may be made as a lean-to against the barn, and will thereby avoid the inconvenience of having a too extended double roof. The division of the yards is a matter which may be left very much to the option of individuals. In the plan proposed there is one large horse-yard (No. 10), 60 feet by 40 feet, which will of course be placed adjoining the stable, and have one of the stable doors opening into it. Next to this are two yards (No. 11), each of them 40 feet square, which may contain eight or ten straw-yard cattle each, and are placed conveniently for receiving straw from the barn. The remaining space, 90 feet in length, is divided into three yards (No. 12) of equal dimensions. Those cattle which are in a somewhat advanced state, and consequently require high feeding, may be placed in these three yards, which are calculated to accommodate five or six oxen each, according to size, and are placed contiguous to the oil-cake place (No. 3). The yards should be divided by walls 6 feet high from the foundation, and should have gates opening to the south for the carriage of manure from the yards. Small gates between them should also be provided for the convenient carriage of straw or food for the cattle. The south wall may be of the same height as the division-walls.

The whole area thus provided for the manufactory of manure, for the conversion of straw into a fertilizer for the soil, will be found to be in the straw-yards, inclusive of that part which is under the sheds, about 9200 square feet, and including the loose boxes or feeding places in the wings, it will be found to comprise somewhat more than 10,000 square feet, which will be found sufficient for a farm of the size proposed. It may be observed that no tanks for liquid manure are provided, but if all the buildings are, as they should be, well spouted, there will be no drainage from the yards to require them. Indeed it is only in ill-constructed farm-yards that anything of the sort is wanted. If, as in this plan, a good proportion of each yard be covered with sheds, and those sheds be spouted, it will be found that practically there is no necessity for liquid manure tanks, as all the rain that may fall into the yards will be readily absorbed. That the buildings should be spouted is, however, absolutely necessary, both for the preservation of the manure from injury, for the prevention of damp in the walls and floors generally, and for the collection of water in summer, which may be obtained in considerable quantity from a large extent of roofing, during a heavy summer thunder-shower.

As to the cost of constructing a farm-homestead upon the plan

and scale here proposed, the estimates would of course vary much in different localities and with different materials. I requested an estimate from an experienced and sensible tradesman, the general result of which I shall here give. The homestead is supposed to be constructed of brick and slate in a substantial manner, with good and well-seasoned timber used for the wood-work. The barn is supposed to be 13-inch work, and the rest of the brickwork, without exception, 9-inch. The spaces between the two roofs, east and west of the barn, to be fitted with lead-gutters; the spouting to be zinc. The size of the spars, side-plates, &c., to be the same that is ordinarily used for buildings of the dimensions proposed, and the estimate includes carriage and every expense connected with the matter. The total amount given was 900*l.*, which includes a liberal allowance for extras of a minor character, and out of it 320*l.* is required for the barn, which is perhaps that part of the plan which would best bear reduction. And when compared with the general expense of new farm-buildings, I think that this sum will be found to be very small, considering the amount of accommodation afforded.

Supposing, however, the sum of money to be expended be limited, the *general arrangement* of the homestead may still be retained the same, at a great reduction in the total cost. Supposing the barn to contain but one threshing-floor, and to be but 60 feet by 20 feet, the rest of the buildings but 15 feet in width and 8 feet in height, the chaff-cutting place and the oil-cake place to be left out, and a high wall be substituted for the loose boxes on the east and west sides of the cattle-yards, supposing pantiles to be used for the roof instead of tiles, and posts and rails to divide the yards instead of brick walls; a homestead may be obtained for little more than half the sum named, not indeed complete as the other, but still possessing many of its advantages, and still providing for the manufacturing of manure under the most favourable circumstances.

With regard to the situation of the homestead, little need be said. The necessary considerations suggest themselves to every mind. It should be as near as possible to the centre of the farm; it should be well supplied with water, and should be on level ground, so that a heavy rain may not flood the yards from the surrounding land.

The stackyard should be arranged along the north side of the homestead at a convenient distance from the buildings. Instead of placing the stacks together in a large square, so that one stack often prevents the possibility of access to another until it is itself threshed, it is far better to place them in a long double row, so that at any time the farmer can take in or thresh which ever stack he pleases. And indeed this arrangement naturally suggests

itself as most appropriate to the plan of farm-buildings that I have proposed.

In submitting a model of the plan here proposed to several experienced practical farmers, the only objection that has been raised, has been with regard to the two roofs which meet one another between the points v and x and y and z. It has been urged that snow might lodge in the intervening space, and at times produce great inconvenience. I have, however, observed that railway-sheds are sometimes constructed with two roofs meeting, and have heard no complaint of trouble arising from the practice. If the objection be felt to be forcible, a roof may be thrown completely over both the stable, cart-shed, &c., and the sheds for the cattle-yard, and the timber used need not be much stouter, as the support of the wall between could be used.

The great consideration to which attention has been paid in this plan, is the arrangement of the cattle-yards in the most favourable position. The theorists, headed by Liebig and Johnston, tell us that if the external state of the bullock be cold, damp, and cheerless, a large portion of the food consumed is required for the production of animal heat. They have also demonstrated, by clear and definite reasoning, that every motion of the animal consumes food: and the practical man comes to the same conclusions. He finds that a yard of cattle, unsheltered from the northern storms, sheltered from the southern sun, lying in a cold and wet yard, never fattens rapidly. He sees, on the contrary, that when cattle are warm and sheltered, well protected from disturbance, they rapidly increase in size and value. And it is believed that, while attention has been principally directed to this subject, the other parts of the building have been placed in their most appropriate position. Thus the barn is conveniently situated for the delivery of straw, is near *every* part of the yards, but nearest to those yards which contain the younger or the growing stock, which may be supposed to consume the straw. The granary adjoins the barn, and can with little trouble be filled with corn when prepared for storing; the oil-cake place adjoins those yards which contain the feeding cattle; the cart-shed being open to the north will preserve the carts from the scorching rays of the sun, and the chaff-houses, stable, and horse-yard, are contiguous.

In conclusion I may remark, that I would most readily acknowledge that many of the *details* that I have given may be probably improved. But that circumstance does not affect the general plan; and I wish this to be regarded as an attempt to establish *principles*, rather than details; as an outline to be filled at pleasure, rather than a finished picture.

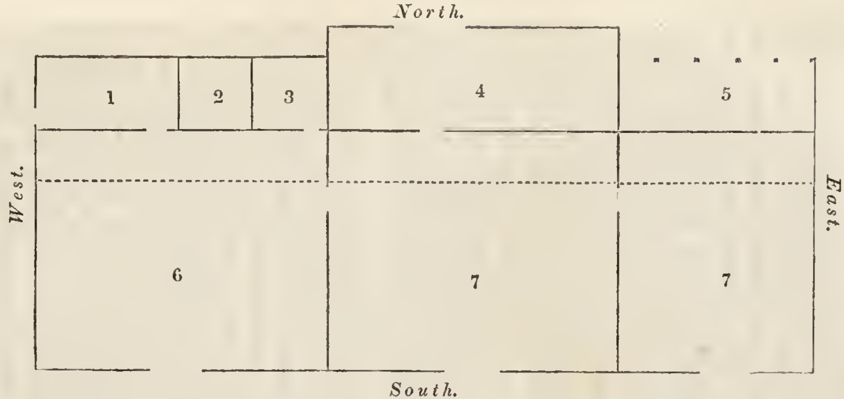
At the time when the preceding paper was written I had not seen any farm-buildings erected upon the plan proposed in it. Since that time I have built a small homestead for 100 acres, carrying out the leading idea embodied in the Essay, and it has received the approval of several intelligent farmers in the neighbourhood. The area given in the Essay for the manufacture of manure is however, I find, too small, and I should recommend that the buildings should be carried 10 feet farther south, which would give 12,500 square feet of yard room, instead of 10,000 feet, as proposed. The spouting, also, should be either cast-iron or cut out of solid wood, in preference to zinc.

I may add, with regard to the cost of erecting buildings upon the method proposed, that I find it would be less than the estimate given. Circumstances, to which I can only allude, compelled me to write the preceding paper in great haste a day or two before the time allowed for competition had elapsed; and at that time I had neither sufficient knowledge of details to accurately estimate the cost nor time to obtain it from others. I now find very considerable reductions may be made. The barn may be reduced in its width, and still remain sufficiently large. The walls of the barn I have estimated as 14-inch work. In consequence, however, of its being so thoroughly supported by surrounding buildings, the end walls need only to be 9-inch brickwork, and the upper *half* of the south wall and the upper *third* of the north wall the same. Other reductions may be made, and, indeed, I am satisfied that a thoroughly substantial homestead may be built upon the plan proposed for about the sum of 750*l*. I have mentioned this, because it is a matter of great importance, in presenting to the public a plan of farm-buildings, that they should be not only convenient in their arrangement, but moderate in their cost. We have had too many model homesteads built which have been so extravagant in their cost as to deter proprietors from attempting to extend to all the farms on their estates the advantages of a well-regulated homestead.

Perhaps a few practical hints may not be out of place. The pillars for open cattle-sheds should be cast-iron placed upon flagstone. These will be found nearly as cheap as wood or brick, and of course far more elegant and durable. Braces will not be needed in the sheds on this plan, and will be better away, as they are apt to cause the hips of cattle to be knocked down. The division walls between the yards should be 14-inch work for 3 feet from top foundation, then tumbled in (as the local term is) for about four courses, and finished with 9-inch-work with a semicircular coping on the top. The outside walls may be 9-inch-work with a pier every seven or eight feet. The barn, if filled from the outside, should have *two* windows for that purpose in each compartment: one immediately under the side-plate, 6 feet in length by 4½ feet in breadth, and under this a smaller window, 4½ feet square, for filling the lower part of the barn. Holdfasts for spouting should be driven into the side-plate *before* the last course of brickwork is put on. If a lead gutter is required, instead of the common method of widening the lead at the upper end, to reach the extra width from one roof to another, caused by the gradual rise in the gutter, the cheaper plan is to line out the spars of the roof and keep the lead the same width throughout. In my own case, the estimate for about 70 feet in length on the common plan was 14*l*., for the one now proposed 8*l*.

I have added two groundplans of homesteads which would be suitable, the one (No. II.) for a small farm where the utmost economy was needed, and the other (No. III.) for a somewhat larger farm than that mentioned in the conditions for the Prize Essay. They are given chiefly to show

PLAN II.—Scale 40 feet to an inch.—Area of Yards about 8,000 square feet.



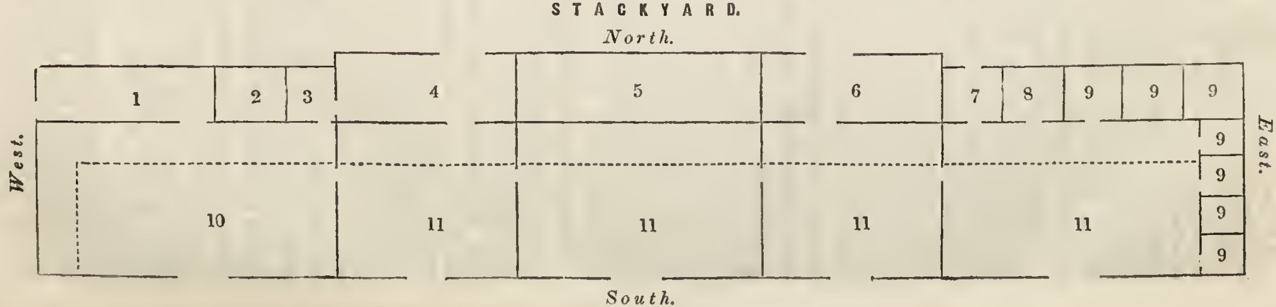
Reference to Numbers
IN
PLAN II.

1. Stable.
2. Chaff-house.
3. Oil-cake place, Granary, &c.
4. Barn, 60 feet by 20.
5. Cart-shed for 5 carts.
6. Horse-yard.
7. 7. Cattle-yards.

Reference to Numbers
IN
PLAN III.

1. Stable.
2. Chaff-house.
3. Chaff-cutting place.
4. Barn, 60 feet by 20.
5. Cart-shed at bottom for 10 carts. Above this, Granary 80 ft. by 20.
6. Barn, 60 feet by 20.
7. Implement-house.
8. Oil-cake, &c.
9, 9, &c. Cattle-boxes, or any general purposes that are required.
10. Horse-yard.
11. Cattle-yards.

PLAN III.—Scale 64 feet to an inch.—Area of Yards about 20,000 square feet.



that I am not confined to any points of detail, and that the leading principle of arrangement which I have proposed may be carried out in a great variety of ways without losing its advantages. Indeed to prescribe one special plan of farm-buildings as suitable in detail to farms which have not been seen, and the special wants of which are not known, seems to me to savour more of the ignorant quack than the true physician.

Bluntisham, Huntingdonshire,
April, 1849.

XX.—*On the Mischief arising from Draining certain Clay Soils too deeply. From* W. B. Webster.

To J. Hudson, Esq.

Dear Sir,—In the last volume of the Royal Agricultural Journal (the tenth), in a letter on the advantage of deep-drainage, the following appears at p. 498:—" I have seen land belonging to the Duke of Wellington at Strathfieldsaye so drained, and upon tenacious clay, as I know from the analysis of it. And with him it has had such good effect that his land-steward is intending by degrees to have the whole of the Duke's estates in Hampshire drained to a great depth, never at a less depth than four feet, but in some instances, according to the nature of the soil, a still greater depth."

Having seen all that had been done at Strathfieldsaye, and knowing that, on the retentive subsoils, the deep drains did not act well, but only on certain portions of springy land that had been drained years ago, I at once wrote to the agent, and received the following reply:—

" Reading, 5th March, 1850.

" Dear Sir,—In reply to your letter of the 18th ultimo, I beg to say that my father is from home, but I can safely inform you that the statement you allude to as being in the 'Agricultural Journal,' that it was our intention never to put a drain in less than 4 feet deep in future on the Strathfieldsaye estate, and by degrees to redrain the estate, is quite *incorrect.*

" An experiment was made on the clay some few years since with the 4 feet deep drains at wide intervals, but it is not found to answer so well in this country as the 3 feet deep drain about 26 or 30 feet apart. An instance has occurred upon the heavy land of some 3 feet drains having been placed between the 4 feet deep drains, which is probably what the writer in the Journal you allude to might have meant, only he should have said that it was the intention never to put a drain upon the heavy clay at a greater depth than 3 feet.

" I am, &c.
" Charles Easton (for Geo. Easton).

" W. B. Webster, Esq."

Previous to bringing the subject before the Society, I was anxious again to see the land myself, which I have now done, and it only requires a person to pass a day on the estate to be convinced that on the dense clay subsoils not surcharged with under-water, 3

feet drains at moderate distances are much more effectual than the deeper at wide intervals. The following letter from Mr. Easton himself, the present agent, will confirm what I say:—

"Strathfieldsaye, 22nd May, 1850.

"Dear Sir,—I intended calling on you yesterday, but was prevented. In reply to your letter of the 18th instant, relative to draining, I beg to state that the system I am pursuing on strong retentive soils is cutting a common channel 3 feet deep from 20 to 30 feet distance from each other, putting in a 2-inch pipe, on which a quantity of heath or brambles are placed before replacing the soil. In porous land I cut the trenches deeper and further apart, according to the nature of the soil, and fill it as before stated. I never allow a pipe of less than 2-inch bore to be used. The deep draining, wide apart (say 60 feet), does not answer so well in the clay or retentive soils as the system we are adopting here, and I find I shall be obliged to put a drain between each of those put in deep and wide apart. I am sorry I was not at home when you called.

"I am, &c.

"W. B. Webster, Esq." "Geo. Easton.

You must remember that I am only opposed to deep drains at wide intervals on certain strong clay subsoils, such as the Weald clay, the Oxford clay, and other extensive clays in the south of England. On these I contend that drains at 3 feet deep, and closer together, are usually better than 4 feet drains at wide intervals. Now if any one will take the trouble to go to the tenant farmers on the estates of Sir Robert Peel and others in that neighbourhood, they will find that the deep drains that answer there are in what is called clay in that country, but is on the red sandstone formation, and not to be compared in stiffness with the clays I have mentioned.

In bringing this before the Society I do so not with the slightest wish to check the progress of deep drainage on the majority of soils, but only to show that there are retentive clays that it will not answer upon.

I am, &c.

9, *Spring Gardens,* Wm. B. Webster.
Dublin, June 25, 1850.

(*Note.*)

It must be now regarded, not as a wholesome caution, but as an established fact, that there are certain clay formations in the south of England on which deep draining is not unlikely to fail. In porous subsoils drains can hardly be too deep, and, as I have said before, will sometimes, if cut round or through a field, lay it dry without any under-draining at all, exhausting wells a quarter of a mile distant. But clay is a merely relative term in agriculture. A clay in Scotland would be a loam in the south of England. In the south we should call no land a strong clay on

which, drain it as you will, you could regularly grow and feed off a turnip crop. Besides, the depth of soil is a material point hitherto overlooked. On the Oxford clay, the strongest of all clays, you may have two feet of good soil, or you may have, as I know to my cost, literally no soil at all. Now since a good soil may be regarded as absolutely porous, the depth of four feet for a drain, though nominally the same, will be really twice as great in the latter as in the former case. In taking leave of the subject, I must say that while the advocates of deep draining have rendered us most essential service, Mr. Parkes, by bringing it into notice, and another writer recently, by eloquently advocating it in a periodical journal, Mr. Webster has done service also in proving the need of caution upon certain exceptional clays. The discussion has helped to draw attention to this important subject, and it was said to me long since by the late lamented Lord Spencer, that the best thing for draining would be a controversy on the depth at which drains should be cut.

Ph. Pusey.

XXI.—*On the Power of Soils to absorb Manure.* By J. Thomas Way, Consulting Chemist to the Society.

In the paper which is now placed before the members of the Society, an attempt has been made to develope, in part at least, a newly observed property of soils, which will, in all probability, prove of great importance in modifying the theory and in confirming or improving the practice of many agricultural operations. The investigation, which has now occupied many months of my personal attention, took its rise in observations made to me fully two years ago by Mr. Huxtable and Mr. H. S. Thompson. The former of these gentlemen stated that he had made an experiment in the filtration of the liquid manure in his tanks through a bed of an ordinary loamy soil; and that after its passage through the filter-bed, the urine was found to be deprived of colour and smell—in fact, that it went in manure and came out water. This, of itself, was a singular and interesting observation, implying, as it did, the power of the soil to separate from solution those organic substances which give colour and offensive smell to putrid animal liquids.

Mr. Thompson, about the same time, mentioned to me that he had found that soils have the faculty of separating ammonia from its solution: a fact appearing still more extraordinary, inasmuch as there is no ordinary form of combination by which we could conceive ammonia to become combined in a state of insolubility in the soil. At the time I was not aware, as I have

since learnt, that Mr. Thompson had, fully three years ago, occupied himself with a series of experiments on the subject; and, with the assistance of Mr. Spence, of York, had arrived at results which left no doubt in his mind that soils possess a specific power for the detention not only of ammonia, but of the salts of this base. Mr. Thompson's experiments are published in another part of the present journal; and although, had the extent of his inquiries been known to me at the time of commencing my experiments, the whole subject would probably have been left in his hands, the agricultural public has in the perfect concordance of result obtained by two experimenters, working quite unknown to and independently of each other, and by somewhat different methods, every guarantee of the perfect accuracy and truthfulness of that result.

It is particularly important in the present case that such a confirmation of the facts should be forthcoming: as although some of the actions—such as that of soils upon the colour and smell of liquid manure—may be demonstrated by very simple experiments, the details of this particular investigation are too laborious to be lightly repeated, and the great mass of information must be received upon the good faith of the operator who has made and described the experiments.

It will be observed that the inquiry has extended far beyond the question of the absorption of ammonia, and that the other bases have been found amenable to a similar law. Some attempt has also been made to trace the *cause* of this very singular action, and with a certain amount of success in pointing out if not to what it *is*, at least to what it *is not*, to be attributed. Much, however, yet remains to be done; and although Mr. Thompson's experiments and those now to be described place beyond dispute the *fact* that soils are gifted with a remarkable power of separating from solution and retaining the salts of manure until required by vegetation, it must be left to further researches to develope the precise circumstances and conditions in which that power is exerted; such inquiries are now being vigorously prosecuted, and there is every hope of ultimate success.

The power of soils to absorb ammonia from the *air* is well known. Professor Liebig, in his admirable work on Agricultural Chemistry, has brought together the existing knowledge upon this subject; and has shown that, besides being brought down to the soil by every shower of rain, ammonia is absorbed by the soil from the atmosphere. He refers this property to the aluminous and ferruginous compounds of the soil, which are known to have a peculiar attraction for ammonia, and likens it to the power possessed by charcoal to condense this gas. But that Professor Liebig had no notion that soils had the power of

separating ammonia from solution in water is evident, since he distinctly states that the alkali so absorbed from the air is separated by the first quantity of rain that falls, and rendered available for plants. He also considers that carbonate of ammonia in the soil is liable to loss by evaporation, and attributes the value of gypsum as manure to its faculty of converting the volatile carbonate of ammonia into the comparatively fixed sulphate of the same base. If the experiments which are about to be described possess any claim to consideration this last supposition must be fallacious, since sulphate of ammonia itself will be found subject to a most important change when it is mixed with the soil. The fertilizing effect of burnt clay is, in like manner, attributed by this illustrious chemist to its power of condensing ammonia: a fact which in itself is sufficient proof that all his remarks upon this head were intended to apply to the abstraction of ammonia from *the air*, and not to its retention in the presence of water. For, as will presently be seen, the burning of clay, which is supposed to render it more active in the sense in which Professor Liebig regarded the absorptive power, has really the effect of destroying wholly or in part its efficacy as an absorbent from solution.

This short explanation is necessary to show that the property in question is totally different from the well-known power of porous substances to absorb ammoniacal and other gases. Nor, if it were the same, would the explanation be sufficient to account for the decomposition by the soil of the different salts of ammonia, and for the power which they will be shown to possess of combining with other alkaline bases, such as potash, magnesia, &c., which have no gaseous character whatever. Neither must the property which we are about to study be confounded with that surface attraction to which the name of capillarity is given. Liquids have a tendency to attach themselves to the smooth surfaces of bodies with which they are brought in contact, and this tendency exhibits itself by raising them in opposition to the natural law of gravitation. It is best exemplified in the case of very minute tubes, open at both ends, which, being dipped into any liquid, cause it to ascend in them to a considerable height above the level of the surrounding solution. But capillary action is equally active, whatever be the form of the surface, so that the interstices are sufficiently minute—thus a piece of sugar thrown into the bottom of a teacup is almost instantly moistened throughout by the ascent of the liquid, which only touches its lower surface. The attraction of capillarity is not the same for all liquids, and consequently it will affect to a different extent a solution of a salt and pure water; it is a surface attraction, and will act in retaining a liquid just in the same way that it does in causing it to attach itself.

Lord Bacon, in his 'Sylva Sylvarum,' speaks of a method of obtaining fresh water, which was practised on the coast of Barbary: "Digge a hole on the sea-shore somewhat above high-water mark, and as deep as low-water mark, which when the tide cometh will be filled with water fresh and potable." He also remembers "to have read that trial hath been made of salt water passed through earth through ten vessels, one within another, and yet it hath not lost its saltness as to become potable," but when "drayned through twenty vessels hath become fresh."

Dr. Stephen Hales, in a paper read before the Royal Society in 1739, on "some attempts to make sea-water wholesome," mentions, on the authority of Mr. Boyle Godfrey, that "sea water being filtered through stone cisterns, the first pint that runs through will be like pure water, having no taste of the salt, but the next pint will be as salt as usual."*

Berzelius found, upon filtering solutions of common salt through sand, that the first portions that passed were quite free from saline impregnation. Professor Matteucci extended this observation to other salts, and found that the solutions when filtered through sand were diminished in density, showing a detention of the sand of eertain quantities of the salt operated upon. Matteucci explains these phenomena on the principle of eapillarity. The particles of the sand have a surfaee attraetion both for the water and the salt, but to a greater extent for this latter, whieh is therefore concentrated and eondensed on the sand, whilst the liquid is proportionably diminished in strength and density. When this attraction has been gratified the solution ceases to be affected, and comes through of its original strength.†

It is to be observed that this property of sand to arrest and separate saline substances from solution is very limited in extent, and requires eareful arrangements to make it evident at all by experiment. It differs also fundamentally from the *chemical power*, which it is the objeet of the present paper to explain, inasmuch as the physieal action of capillarity is exerted on the *whole salt*, whilst that we are about to describe has relation only to the *alkaline or earthy base*. Furthermore, the former property is only the resultant of two opposite forces, that of the surface attraetion of the sand and of water for the salt. It can only therefore operate a condensation of the salt in relation to the strength of the solution, the salt being eontinually shared in given proportions between the sand and the water, so that eventually the whole is washed away. Such, however, is not the case with the compounds which are formed in the soil with solutions of different alkaline

* I am indebted to my friend, Dr. Smith, of Manchester, for calling my attention to these two recorded instances of the effect of filtration on salt water.

† 'Sur les Phénomènes physiques des Corps vivants,' p. 29. Paris, 1847.

bases, for so far as the experiments have gone they appear to be wholly insoluble in pure water.*

There is a further power possessed by sand in relation to organic solutions which it is very necessary to advert to in order that it may not be taken in explanation of the faculty which soils will be shown to possess of arresting organic and especially animal matters. Dr. Angus Smith, in his examination of the waters of towns, had frequently observed the presence of large quantities of alkaline nitrates in the water of shallow wells. Suspecting the animal origin of this nitric acid, he instituted experiments upon the action of filters of sand and other porous bodies upon solutions of different animal and vegetable matters, and he found that in such circumstances oxidation took place most rapidly—the nitrogen of organic matters being converted into nitric acid, the carbon and hydrogen also combining with oxygen at the same time. Thus a solution of yeast, which contained no nitric acid, after being passed through a filter of sand gave abundant evidence of salts of this acid. Coloured solutions were in this way more or less decolorized. Water rendered brown by peaty matter was found to be purified by filtration through sand. These and other very interesting experiments are explained by Dr. Smith on the principle that sand by its surface attraction for air is a powerfnl oxidating agent, and that the filtration through such a medium is the most perfect way of exposing a solution to the influence of oxygen.

Dr. Smith's experiments serve to explain the rapidity with which manure disappears from sandy soils, but it is clear that there is a power of an opposite kind brought into action in good loamy soils which retain manure, although in extent of acting surface and permeability to the air, they are little if at all inferior to sandy land. This power is evidently that of clay, which will be seen as we proceed to be antagonistic to the oxidating power of sand, combining with organic matters, and retarding rather than hastening their destruction. Nitric acid has not in any case been found in these experiments to be a product of the filtration of organic matters through soils containing a fair share of clay, whilst, on the other hand, colouring matters are actually

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* Mr. Bernays, in a communication to the Agricultural Gazette (Oct. 20th, 1849), describes some simple experiments of filtration made by him, the result of which is evidently due, partly to the law of capillarity, and partly to the chemical action of the soil. Mr. Bernays found that a solution of common salt was diminished in strength by filtratiou through a soil, and that the diminution was in proportion to the *depth* of the filtering column, and he used this as an argument for deep drainage. The *depth* of the filtering column has no further influence upon the result than that it brings into play a larger quantity of the absorbent substance; and since different soils are shown in the present paper to possess a different power of absorption, no absolute rule for the depth of drainage can be founded on this property of soils.

precipitated unchanged, or in the state of insoluble pigments (technically known as "lakes"), by mere mixture with white clay.

Neither to the action of capillarity then, or to that of oxidation, are we to attribute the property of soils to retain the mineral bases and animal and vegetable ingredients of manure. The action is one indeed *sui generis,* and in an agricultural point of view of much greater importance and interest than either of those mentioned. We shall now proceed to describe the experiments that have been made, merely premising that the present paper is to be regarded simply as a report of progress, and does not profess to give more than an outline of the facts, leaving the results of further investigation to be described in future contributions.

Two of the soils frequently alluded to were employed in the outset merely from motives of convenience, as they happened to be in the laboratory at the time: the one of these is a red soil from Mr. Pusey's estate in Berkshire, the other a loam from Mr. Huxtable's farm on the chalk hills of Dorset. It may become a point of importance at a future time to ascertain how far the absorptive power of a given soil bears relation to its known capabilities of bearing crops, and the principle may happily become available as a means of classification for soils; but in the first inquiries it seemed quite immaterial what soils were employed. One of the above soils,* that from Mr. Pusey, was sent to the laboratory to be

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* This soil was sent to Mr. Way as the only unmanured specimen remaining of my own farm, and I may mention that the analysis singularly confirmed the anticipation which on chemical principles I had formed as to the result. The land, which had been badly farmed, though it bore wheat and barley after such dung as it got for the wheat, had produced no turnips, the dung being worn out in the fourth year of the course, and next to none being given to the root-crop. With superphosphate and peatashes I produced luxuriant crops of turnips; the former supplying phosphoric and the latter sulphuric acid. This led me to suspect that the soil was deficient in both those ingredients, and Mr. Way's analysis shows that it is totally wanting in both. Mr. Way's conjecture that the addition of gypsum might sometimes be beneficial is borne out by the fact, as peatashes, which contain it, are beneficial on this farm both to clover and turnips, both plants containing sulphuric acid. It is perhaps material to remark, with regard to the power of the soil to absorb manure, that the specimen submitted to Mr. Way was in a natural state. After its condition is raised its absorptive power might not be so high.—PH. PUSEY.

analysed; by his permission the result of the analysis is now given:—

Analysis of Mr. Pusey's Soil.

When dried in the air, 100 parts contain—

Water	20·56
Vegetable matter	6·17
Sand and clay (insoluble in acids)	59·00
Phosphoric acid	none
Carbonate of lime	5·94
Magnesia	none
Oxide of iron and alumina	7·90
Potash } dissolved out by acids	0·31
Soda } dissolved out by acids	0·12
	100·00

Mr. Huxtable's soil was not analysed, but the pottery clay, to which it will be frequently necessary to allude, was carefully examined. The clay in question is a white bed of the "plastic clay" formation, which is worked for the purposes of pottery in the neighbourhood of Farnham. It was obligingly furnished to me by Mr. Paine; the masses sent up were taken from a depth of nearly 20 feet from the surface; and it is remarkable, as an instance of the tendency of clay to unite with ammonia, that a small portion, taken from the centre of the mass (and which had consequently no opportunity of absorbing any gaseous substance from the air) was found to give off abundance of ammonia when heated in a tube.

There are two possible ways in which the clay might have acquired this ammonia—either in the course of ages water, penetrating to the depth of 20 feet through a most impervious stratum of clay, may have carried with it some portion of ammonia; or the clay must have absorbed ammonia from the water in which at a remote geological period it was suspended before deposition in its present place.

The first of these suppositions is improbable on account of the almost physical impossibility of water percolating the mass, and because, as the clay is not nearly saturated with ammonia, it would not have been likely to have reached these inferior layers at all.

There is little doubt, therefore, that the ammonia found in the clay was derived from organic bodies decaying in the very water from which the clay was deposited. We could hardly have a more striking instance of its power of absorption and *retention* of ammonia in despite of water, to the action of which it must have been at that time exposed for a very lengthened period.

Analysis of White Clay.

When dried at 212°, it contained, in 100 parts—

Insoluble in acids, 58·03	Silica	42·28
	Alumina	11·45
	Oxide of iron	3·53
	Lime	0·55
	Magnesia	0·22
Soluble in acids, 41·97	Water of combination	6·15
	Silica	18·73
	Alumina	12·15
	Oxide of iron	2·11
	Lime	0·27
	Magnesia	0·29
	Potash	0·86
	Soda	1·41
		100·00

It will be observed that a boiling mineral acid is unable to dissolve out all the lime from the clay; and it is this remaining lime which enables the clay, as will presently be seen, after treatment with acid, to absorb ammonia in very slightly diminished extent.

We now proceed to describe experiments on the filtration of different solutions through soils.

On the Absorption of Ammonia.

Experiment No. 1.—The tube employed in this experiment was 20 inches long and ¾ inch in internal diameter. When about two-thirds filled with soil it contained 2800 grains of the latter. The soil used was Mr. Pusey's red soil in coarse powder, dried in the air. The solution of ammonia employed was made by diluting 1 ounce of the strongest ammonia with 11 ounces of water. It contained therefore about 1·5 per cent. of real ammonia, and was of course highly pungent to the smell. The solution took from 1½ to 2 hours to run through. The first portions were found to be entirely free from the pungent smell of ammonia. When 1 ounce of liquid had percolated, it was examined by the usual tests for free ammonia, and by the help of solution of potash for salts of ammonia, but no trace of the alkali in any form was detected in it. The experiment was discontinued at this point. On pushing out the wet soil from the tube, the lower portions being the first ejected, the smell of ammonia became powerful at once, as if the presence of an atmosphere of common air assisted its volatilization, although the liquid was unable to bring it away, but subsequent experiments proved beyond a doubt that this circumstance was merely accidental, and that had the operation been continued the ammonia would shortly have passed through, the soil being saturated with it.

Experiment 2.—The same soil powdered and made to pass through a sieve of 80 holes to the inch. The tube was much shorter than in the previous experiment, and the column of soil about 1 foot in depth, weighing about 1500 grains. The solution of ammonia was, on the other hand, much stronger than in Experiment No. 1; it consisted of equal parts of strongest ammonia and water. Only so much liquid was used as to sink through the soil without dropping from it. The solution and soil were

left in contact for 24 hours, and then a fresh portion of the former was added; what now came away was perfectly free from ammonia, and fully half an ounce was collected in which neither ammonia nor its salts could be detected.

The solutions of ammonia in these first two experiments were evidently unnecessarily strong, and it required close attention to observe the different stages of the absorptive process. A standard solution to be employed in the succeeding experiments was therefore made by diluting 1 oz. of strongest ammonia with 60 ounces of water; this solution was analyzed approximatively, and found to contain about 0·3 per cent. of real ammonia. Although thus diluted it was highly pungent to the nose.

Experiment 3.—5000 grains of the same soil in coarse powder, in a tube 24 inches long; the column of soil occupying 18 inches; solution of ammonia (·3 per cent.) poured upon it. The solution took about half an hour to percolate, and about 4 ounces came through before ammonia or its salts could be detected.

At this stage of the investigation the idea suggested itself, that the effect observed might be nothing more than a mere displacement. The soil employed was simply dried in the air, and, although pulverulent, was found still to contain 20 per cent. of water. It might reasonably be supposed that the solutions in filtering downwards would *displace* this water, which would first issue from the bottom of the tube, and would of course contain no portion of the substance with which the experiment was made; that this might be a fertile source of error, will be understood by reference to the last experiment, in which 5000 grains of soil being employed, 1000 grains of water, or more than 2 ounces, would have to be displaced. The obvious method of checking the result would be to dry the soil before the experiment; but in the absence of any knowledge at the outset of the nature of the supposed action, it was by no means clear that if such a property did really exist, it might not be destroyed by such desiccation. The following experiment was therefore designed to settle this point.

Experiment 4.—The same soil was passed through a sieve of 40 holes and retained by another of 80 holes to the inch, so as to ensure a filter of uniform character. Upon a column of 18 inches of the above a strong solution of *common salt* was poured: owing to the equable size of the particles of soil the solution did not require a lengthened time to pass. The first drop, which came through in about five minutes, was tested by nitrate of silver, and gave abundant indications of chlorine.

Experiment 5.—A similar trial with exactly the same result.

The rapidity of the filtration, and the strength of the solution of salt, seemed to render this experiment less satisfactory than it otherwise might have been. The next is not open to the same objection.

Experiment 6.—The same soil passed through a 40-hole sieve, but the fine portions not removed as in the previous experiments. A much weaker solution of salt employed. The very first drops of liquid gave, by nitrate of silver, a copious precipitate.

From these experiments it is obvious that whatever may be the nature of the action, it is a *bonâ fide* absorption of the ammonia of the soil. The result would seem to prove incidentally that *common salt* is not subject to any absorption by filtration through a soil; but experiments to be presently detailed, serve materially to modify such an opinion.

The following experiment on dried soil is confirmatory of those that were made with common salt; it also proves that the absorptive power is not destroyed by drying:—

Experiment 7.—A quantity of the same soil was dried on a sand-bath for many hours at a heat varying between 130° and 160° F. A solution of ammonia (of the same strength as in Experiment No. 1) was poured upon a column of 14 inches, weighing 2800 grains. Owing to the finely divided dusty state into which the drying had brought the soil, the solution took three hours to percolate; when it came through it was entirely free from ammonia, and so continued until fully 1 ounce had passed, when it became ammoniacal and coloured. Before the ammonia came through a small portion of the wet soil was picked out from the lower portion of the tube, but it did not smell at all of ammonia, which had, therefore, not yet reached it.

Another important preliminary inquiry seemed to be, whether a difference in the result would be likely to occur from a shorter or more prolonged exposure of the solution to the action of the soil. So far as filtration was concerned, it seemed obvious that a very rapid passage of the solution through the soil being due to an imperfect contact of the two—the liquid passing *between* rather than *through* the little masses—would fail to produce the ultimate effect. But it did not appear whether, supposing the acting surface in the most favourable state, the absorption would take place rapidly and to the full extent, or would require a lengthened time for its exhibition. The following experiments were made to elucidate this point:—

Experiment 8.—A tube of 24 inches in length was partially filled with soil, so arranged that the liquid (ammonia of ·3 per cent.) could be forced through it by means of a syringe. In this way the solution was made to pass in something less than two minutes, whereas without such pressure it would have required from one to two hours. The first 3 ounces that came through were quite free from ammonia or its salts. The experiment was not continued, as the apparatus would not bear the pressure.

Experiments 9 *and* 10.—Repetitions of the previous experiment, with precisely analogous results.

Experiment 11.—In this experiment the soil was dried for five or six hours on the sand-bath. It was then sifted through a sieve of 80 holes to the inch to separate the dust, the coarser part being employed in the experiment. The object of drying and sifting in this case was to hasten the

filtration. The same ammoniacal liquid was employed, and, with the aid of a syringe, 4 ounces were passed through by a few strokes of the piston in twice as many seconds, containing no ammonia either free or in combination.

These three last-described experiments are interesting, as indicating the rapidity with which the absorption of ammonia by the soil takes place—a circumstance which leads us to liken the action to chemical combinations of the most powerful kinds, such as those of mineral acids for alkalis or alkaline earths. It also appears that in conducting experiments on this subject there is no occasion for any *prolonged* action of the soil upon the solution, provided that the perfect *contact* of the two is attained. The *practical* bearings of this point are very important, but will be discussed at a future opportunity.

Although it did not seem probable that this particular soil should possess so singular a property, whilst others should be found destitute of it, it was thought advisable to operate upon other specimens. The following experiment was made with the thin soil of the Dorsetshire Downs obtained from the Rev. Mr. Huxtable. It is singular that this soil, which is only a few inches above the chalk, does not give a perceptible effervescence with acids.

Experiment 12.—The column of soil in this experiment was 18 inches, weighing 2390 grains. The solution of ammonia of the same strength as before (·3 per cent.). The liquid began to come through in about half an hour, and when more than 3 ounces had passed no evidence of ammonia or of its salts was obtained in it. The experiment was not carried further.

Here then we have a second loamy soil which possesses the power of arresting ammonia. The next experiment is with a yellow clay, which forms the subsoil of Mr. Huxtable's lower farm; the clay was not examined minutely, but it was ascertained that although containing little carbonate of lime, it was considerably impregnated with gypsum.*

Experiment 13.—Mr. Huxtable's clay powdered and passed through 20-hole sieve, and, in order to make it permeable, mixed with its own weight of well-washed white sand. The mixture occupied 18 inches in the tube, and upon it solution of ammonia of the usual strength was poured. The first portions came through in about two hours, and several ounces passed the tube, but no ammonia was found in the filtered liquid.

These experiments upon three different soils were considered conclusive as to the existence of the property more or less in all

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* The ear is familiar with the name of gypsum as a "fixer" of ammonia, and from the fact of this soil containing it some readers might suppose that the result is due to its presence. Gypsum, however, only "fixes" ammonia by converting its volatile carbonate into the sulphate of ammonia, which, although not liable to loss by evaporation, is equally soluble as the carbonate, and would pass through the soil were it not for the power under investigation.

ordinary soils, and the further examination of particular specimens was reserved to another period of the investigation.

The power of soils to separate ammonia from solution being beyond a doubt, it next became a question to ascertain to what ingredient the property is attributable. An ordinary soil consists principally of three substances—sand, clay, and vegetable matter. To these may be sometimes added a fourth, namely, carbonate of lime.

In the soils with which the previous experiments were made, only a very small proportion of carbonate of lime occurred; and the inquiry is therefore limited to sand, clay, and vegetable matter. The following experiments were made with sand.

Experiment 14.—A tube 18 inches long, filled to within two or three inches of the top with well-washed white sand; solution of ammonia of the former strength passed through. The very first drops that passed were found to be strongly pungent, aud on comparing the first half-ounce with the original liquid no difference could be observed.

Experiment 15.—Sand of a much finer grain well washed and dried, 4000 grains; solution of ammonia as before. Owing to the fineness of the particles the solution did not begin to drop from the tube in less than 10 minutes. The first portions coming through appeared in no way affected by the filtration.

Experiment 16.—As the last, the column of dried sand being somewhat longer, 18 inches. The first liquid, which came through in a quarter of an hour, smelt of ammonia, but it was thought, when compared with the ammoniacal solution, to be somewhat weaker: if, however, this difference really existed, it soon disappeared as further quantities came through the filter.

These experiments sufficiently prove that the power is not to be ascribed to sand. The last result was thought at the time in favour of the existence of a surface attraction of a feeble kind which sand and other granular substances might exhibit to a solution such as that of ammonia. The power possessed by charcoal, and some other bodies, of condensing gases and vapours, is plainly in relation to the surface exposed, and might be expected to remain active although the gas or vapour were in solution in water. In the same way sand might operate a condensation of the ammonia of the solution on its surface, and the liquid coming away would be correspondingly diminished in strength. Whether this is so or not, it will be abundantly evident as we proceed, that the absorptive power of soils is something entirely different from a surface attraction.

To ascertain whether the vegetable portion of the soil had any share in the action, the soils in the succeeding experiments were burnt before being used in the filtrations. At the same time it was thought quite possible that the evidence thus obtained would be unsatisfactory, inasmuch as burning might alter the character

and composition in other respects, besides the destruction of the vegetable compounds.

Experiment 16.—Mr. Pusey's soil, burnt in a *covered* Hessian crucible in the laboratory furnace. As the air had not free access, the quantity of charcoal distributed through the soil upon the cooling of the crucible was found to be considerable. The tube and the ammoniacal solution were the same as in Experiment No. 1. Owing to the solidification of the particles produced by the burning, the liquid sank through very rapidly, and coming through in less than five minutes, did not appear to be at all diminished in strength.

It was a second time passed through, with no better result.

Believing that this failure might be due to the too rapid percolation of the liquid, and also to the circumstance that the solution might not obtain access to the interior of the indurated particles of soil, the following experiment was made:—

Experiment 17.—The same burnt soil finely powdered and rammed down little by little into the tube. The liquid now percolated much more slowly; the first drops which passed were found to have a very slight, but yet perceptible, odour of ammonia, and soon afterwards the ammonia came through in abundance.

Experiment 18.—Mr. Huxtable's loam burned in covered crucible. All organic matter was destroyed, but the charcoal in great part remained; 18 inches of this soil was used as the filter for the standard weak solution of ammonia (·3 per cent.). After about an hour, half an ounce passed, in which no ammonia could be detected; caustic potash, however, showed the presence of some ammoniacal salt, though in small quantity; subsequently it came through to all appearance undiminished in quantity. It was evident that the burnt soil had the power of retaining ammonia, though in no way to compare with that of the unburnt.

In the preceding experiments the soils used were cultivated soils, and contained much vegetable matter, yielding a corresponding quantity of charcoal when burnt. The two next were made with a stiff subsoil clay which contained comparatively little organic matter.

Experiment 19.—A stiff clay from Mr. Huxtable, burnt in a covered crucible for half an hour, and subsequently powdered. Part was black, but the greater portion was red, like brickdust: the burnt clay was mixed with its own weight of white sand, and the standard solution passed through a column 16 inches in height. About half an ounce of liquid came through free from ammonia or its salts, but the power of the clay was sensibly diminished by the burning.

Experiment 20.—The same clay passed through a sieve of 20 holes to the inch, to ensure its being equally acted on by the heat, and then burnt; very little charcoal remained in the red brickdust thus produced. The solution of ammonia came through at once, and appeared undiminished in strength.

Experiment 21.—The same clay sifted as before and burnt very strongly for two hours. The heat was sufficient to harden the clay into little lumps. It was powdered again and made to pass through the same 20-hole sieve. The column of the filter was about 15 inches in depth. The first drops, which came through in about 20 minutes, smelt strongly of ammonia, and, so far as could be judged, no diminution of the strength of the solution had taken place.

The first three of these experiments (16, 17, 18) are rather unsatisfactory. They show, indeed, that the power of a soil to combine with ammonia is greatly diminished by burning it; but they leave it in doubt whether the little influence which remains is to be ascribed to the mineral elements of the soil or to the charcoal, which is known to possess a similar property. The experiments with the clay are more decisive, but do not afford conclusive evidence. It would seem, however, that the more perfectly (or rather strongly) the soils were burnt, the more completely was their absorptive power destroyed. This was very evident in the last experiment, where the clay was almost fused by the heat. Acting upon this impression, the next step in the inquiry was to employ filters of the most perfectly burnt clay, and bricks and tobacco-pipes appeared likely to answer this character.

Experiment 22.—A soft red brick was broken in a mortar, and the powder passed through a sieve of 20 holes to the inch; a stratum of 16 inches in depth was used as the filter for the standard solution of ammonia. The first drops that came through smelt strongly of ammonia.

Experiment 23.—The same brickdust passed through a much finer sieve (of 60 holes to the inch); the column of the filter and the solution the same as in No. 22. The smell of ammonia was perceptible from the very first, and it soon became quite as powerful as in the original liquid. The solution became very yellow, smelt strongly of soot, and contained sulphate of lime: some of the ammonia in it was in the state of sulphate.

Experiment 24.—In this experiment the brickdust and solution being the same as in No. 23, only so much of the solution was added as to pass down without running out of the tube; the materials were then left in contact for two hours, the object being to give time for the perfect contact of the brickdust and the ammoniacal solution. Upon adding more liquid the first portions coming through gave with potash indications of ammonia, to all appearance in equal quantity with the original solution.

Experiment 24.—A repetition of the last, with the same result.

As a variation of these last experiments, a trial was made of the action of powdered tobacco-pipes upon ammonia. The clay with which tobacco-pipes are made is of a very pure character, being almost entirely free from oxide of iron, which colours the red bricks. In the manufacture of pipes, this clay is also very carefully and perfectly burnt, both of which peculiarities seemed to fit it for a trial in these experiments.

Experiment 25.—Tobacco-pipes were broken in an iron mortar and the powder passed through a sieve of 40 holes to the inch. The standard solution of ammonia was poured upon a column of 12 inches of this powder. The liquid was slow in filtering, but when it came through neither ammonia nor its salts could be detected.

Experiment 26.—A repetition of the previous experiment, the pipe-dust being mixed with its own weight of sand to hasten the filtration. The liquid coming through was free from ammonia or its salts.

Here, then, we have a contradictory result. A specimen of powdered red brick appears entirely devoid of absorptive power,

whilst the powder of tobacco-pipes, equally well burnt and equally devoid of organic matter or charcoal, exhibits the property in considerable intensity. The next experiment was with pipe-dust of tobacco-pipes obtained from a different locality, and in all probability made from a different bed of clay.

Experiment 27.—Pipes of another manufacture broken and sifted (40-hole sieve); the powder mixed with its own weight of sand, and a column of 18 inches used as the filter; the standard solution of ammonia. The liquid began to come through in one hour. The first few drops were free from ammonia, which, however, was quite perceptible before a quarter of an ounce had passed.

Experiment 28.—The same pipes broken and sifted through a sieve of 20 holes to the inch. The column of powder used being 14 inches, with the same solution of ammonia. The liquid came through in about two hours, and the first half-ounce contained no ammonia in any form.

These experiments certainly gave the impression at the time that different specimens of clay would be differently influenced in regard to their absorptive powers by the process of burning. It is easy to conceive that at a temperature only short of that necessary for the fusion of the materials of the clay, new compounds may be formed in it, and previously existing combinations destroyed; and that one clay varying from another in the relative quantities of silica and alumina, and in the possession of small quantities of the silicates of other bases, the effect of heat would in the one case be very different from that in another. The power possessed by well-burnt pipeclay, although much inferior to that of the natural clay, is yet sufficiently appreciable; and its existence is quite irreconcilable with the notion that the absorption of ammonia by soils is due to the production of any organic compounds. But on this subject more important evidence will be forthcoming as we proceed.

It seemed important at this stage of the investigation to make use of a clay as pure as possible, and which had neither been exposed to the influence of the air nor of vegetation. A clay also free from oxide of iron was to be desired. For this purpose a quantity of white clay, of the plastic clay formation, was obtained. It was dug from a pit at about 20 feet below the surface, and contained no vegetable matter.* It is much used for making pottery.

Experiment 29.—White clay powdered, 1500 grains, white sand an equal quantity; the mixture formed a column of 14 inches, through which a strong solution of ammonia was passed. The first portions were free from ammonia or its salts, but it soon began to percolate.

The solution of ammonia employed in this case was too strong. (It was one of the early experiments.) The next are more satisfactory.

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* For analysis of this clay see p. 320.

Experiment 30.—White clay 1000 grains, sand 5000 grains, forming a filtering column of 18 inches; ammoniacal solution of ·3 per cent. The solution percolated in about two hours, and the first portions of liquid collected, measuring two ounces, were decidedly free from ammonia.

Experiments 31 *and* 32.—Repetitions of the preceding experiments, with similar results.

Experiment 33.—The same white clay strongly heated for two hours in a covered crucible. When used as a filter it did not require, as in the previous case, to be made pervious by admixture of sand. A column of 18 inches was employed with solution of ammonia of ·3 per cent. The first half-ounce which passed was free from ammonia or its salts, but the absorptive power appeared sensibly diminished, though anything but destroyed.

The following experiments, illustrative of the influence of acids upon the absorptive powers of soils, are interesting:—

Experiment 34.—Mr. Huxtable's light soil was digested with strong nitric acid, and after gentle evaporation to dryness the mixture was exposed to a heat of between 300° and 400° Fahr. till all the nitrous fumes were driven off; more nitric acid was then added and heat again applied, the operations being repeated successively till the nitric acid was no longer decomposed upon its addition. The object of using nitric acid was to destroy the vegetable matter of the soil without the necessity of heating it to such an extent as to alter the chemical arrangement of its mineral ingredients. The prepared soil was mixed with its own weight of sand, a column of 18 inches of the mixture being employed, and standard solution of ammonia passed through it. The liquid when it came through was strongly coloured with salts of iron, and gave abundant indications of alumina, as might be expected: but nearly two ounces passed before ammonia or its salts could be detected in it.

The interest of this experiment consists principally in the circumstance that the destruction of the vegetable matter does not deprive the soil of its power of absorbing ammonia, provided that it is effected by agencies which do not materially alter the mineral matters. It is also worthy of remark that the conversion of any free alumina in the soil into a salt of that base does not destroy the absorptive power. The following experiment on the action of hydrochloric acid is still more important in the latter sense:—

Experiment 35.—The same soil (Mr. Huxtable's) digested with hydrochloric acid diluted with an equal weight of water. The materials were heated nearly to boiling for several hours, and were then left to digest for 24 hours, being frequently shaken during that time. The acid liquid, which contained much alumina and oxide of iron, was poured off, and the soil repeatedly washed with distilled water till all traces of the acid were removed; it was then carefully dried. The soil thus prepared was mixed with its own weight of sand, and upon a column of the mixture, of 18 inches deep, the standard solution of ammonia was poured. The liquid took a long time to filter, but when it came through neither ammonia nor its salts could be detected. About two ounces of the solution had passed before any ammoniacal compounds were discovered in the filtered liquid.

It is well known that alumina forms a large proportion of all fertile soils, and it is not at all certain that it does not exist in

some cases in a free state—that is to say, uncombined with silica or any other acid. Further, alumina has a tendency to play the part of a weak acid, and to unite with different bases. The power, therefore, of absorption possessed by soils, and now under investigation, might very reasonably be supposed to reside in the alumina. Whether this is so or not will appear as we proceed; but, in the meanwhile, it will be observed that the two experiments which have been just described are much opposed to any such view.

Up to this point the experiments that have been described were made with the different soils, and free or caustic ammonia: it becomes now necessary to mention the effects produced by soils upon the salts of this alkali.

Absorptive power of soils for *carbonate of ammonia*:—

Experiment 36.—500 grains of the carbonate of ammonia of the shops dissolved in 16 ounces of water, and a stream of carbonic acid passed through it for a quarter of an hour. This solution being poured upon a column of 12 inches of Mr. Pusey's soil, began to drop through in about an hour, and after more than an ounce had passed no smell of ammonia was perceptible in it, nor did the addition of caustic potash produce any. It is worthy of notice that the addition of potash to the filtered solution gave a copious precipitate, which proved to be lime.

Experiment 37.—A repetition of the preceding, with the same result.

Carbonate of ammonia is then subject to the same absorption by the soil as the caustic alkali: this is very important, since the ammonia existing in the air and brought down to the soil by rain is in the state of bi-carbonate of ammonia. Great part of the ammonia produced in the natural decay of nitrogenized manures is also in combination with carbonic acid. The practical interest of this absorptive property of soils would, therefore, be much limited if the power only had reference to the free alkali. It is, however, encouraging to be able to depend upon this power for the preservation of not only ammonia and its carbonate, but of all other combinations of this valuable substance. The following experiments have reference to some of these salts.

Sulphate of ammonia:—

Experiment 38.—500 grains of sulphate of ammonia dissolved in 16 ounces of water. The solution was slightly acid to test-paper; Mr. Pusey's soil as a filter-bed of 12 inches. The solution of sulphate of ammonia percolated in about $1\frac{1}{2}$ hour; the first portions gave no indication of ammonia upon the addition of potash; it contained from the first, however, abundance of sulphuric acid in combination with lime. Several ounces were collected free from ammonia or its salts, but the quantity was not accurately observed, as portions were used from time to time for the operation of testing.

Experiment 39.—A filter-bed of 18 inches of Mr. Huxtable's soil, with solution of sulphate of ammonia of unknown strength, but giving off

copious ammoniacal vapours when treated with potash. Altogether three ounces of the liquid percolated without a trace of ammoniacal salt, but, as in the last experiment, sulphuric acid was present in the very first portions, combined, as in the previous case, with lime. So strongly was the liquid impregnated with sulphate of lime, that the salt separated from it in flakes after standing a few minutes.

In the two experiments just described we meet with a remarkable circumstance. Sulphate of ammonia obeys the law of absorption so far as the ammonia is concerned, but its acid unites with lime, and comes through in solution. The salt is not absorbed as a whole, but only the *base*. The acid with which it is combined forms a soluble salt with lime, which is subject to the ordinary laws of filtration, and is not, as will be seen presently, in any way retained by the soil.

The power of absorption, to whatever it may be due, would thus seem to be one acting only on the alkaline base, and not on the whole salt. And in this respect it differs entirely from a surface attraction, which would be supposed to act upon the whole salt. The fact that by the help of lime the soil possesses the same power for the retention of the salts of ammonia as for the free base itself, opens up a mine of speculation of the greatest promise in reference to practical agriculture. These questions immediately present themselves:—In what form must lime exist in the soil in order to play this part efficiently? Is it carbonate of lime, or caustic lime, or what other compound of this base? Do all soils contain sufficient of it for the purpose? and if not, how will it be best applied?

Reserving, however, such inquiries as these until the subject is somewhat more fully developed, we pass on to give an account of experiments with other ammoniacal salts.

Nitrate of ammonia:—

Experiment 40.—Mr. Huxtable's soil mixed with its own weight of sand, the filtering-bed being 12 inches in depth. The solution of nitrate of ammonia employed was sufficiently strong to give, when mixed with potash, abundance of ammoniacal vapour. The first portions passed in about an hour, and were found to contain no portion of ammoniacal salt. When tested by sulphate of iron and sulphuric acid the liquid gave abundant indications of the presence of nitric acid, combined, as it proved upon examination, with lime.

Experiment 41.—Nitrate of ammonia in solution was poured upon Mr. Pusey's soil—the filter-bed being, as in the last case, 12 inches deep. A considerable quantity passed through without any ammoniacal compound, but affording nitric acid from the first.

Although these experiments were not considered in the light of quantitative trials to decide the *extent* of the absorptive power in soils, still it could hardly escape notice that the action in some cases was much more powerful than in others. In the last

experiment with Mr. Pusey's soil, the amount of absorption seemed greatly to exceed that of Mr. Huxtable. At this time the impression left by the experiments was that the lime was derived from carbonate of lime, which, with the different salts of ammonia, would give carbonate of ammonia, and a salt of lime corresponding with the acid of the salt employed. This view presumed that the carbonate of ammonia was the compound really absorbed by the soil; it appeared, therefore, to be quite possible that the superiority of the one soil over the other for the absorption of ammonia from the nitrate, might be due to the presence of a larger quantity of carbonate of lime; and the following experiment was made with the view of testing the accuracy of this opinion :—

Experiment 42.—Mr. Huxtable's soil mixed with half its weight of sand and an equal quantity of powdered chalk; solution of nitrate of ammonia was passed through it, as in the other cases; but so far as might be judged, the addition of the chalk did not alter the absorptive power.

Muriate of Ammonia.—Several experiments in the filtration of a solution of sal-ammoniac through different soils were made, with results in all respects similar to those which other salts of this base afforded, the ammonia being detained, whilst the chlorine was found in the liquid in combination with the base of lime. As, however, some quantitative experiments to be presently described will give all the information necessary with regard to the action of soils upon this salt, it will be unnecessary in this place to enter into further details.

The instances that have been adduced fully substantiate the law to which there would appear to be no exception, that soils possess the power of arresting and combining with ammonia and perhaps its carbonate, and through the agency of lime with the ammonia of the sulphate, nitrate, muriate, and other salts of this base. That sulphate of ammonia should be so acted upon seems the more extraordinary, inasmuch as the formation of this very salt has been looked upon as the way in which ammonia and its carbonate would become more fixed in the soil and less exposed to loss by evaporation when applied in manure.

Sulphate of lime (gypsum) has been greatly recommended and extensively employed to fix, as it is called, the ammonia of decaying animal or vegetable matter, and in the preparation of manure it is undoubtedly highly useful for that purpose. The way in which it acts is simply this:—Carbonate of ammonia, the common product of the decay of all nitrogenized matter, and the form in which ammonia exists in the air, is very volatile. Sulphate of ammonia is a much less volatile salt, and requires, indeed, heat for its dissipation in any quantity. When sulphate of lime is brought in contact with carbonate of ammonia, mutual

combination takes place, and the result is carbonate of lime and sulphate of ammonia. The change acts beneficially by producing a more fixed salt, which has no great tendency to escape into the air, but it does not protect from loss where water gains access, because the sulphate of ammonia is a highly soluble salt.

Here, however, comes the great peculiarity, when we have in addition to deal with the soil. The sulphate of ammonia gives up its acid to lime, and sulphate of lime comes through in the filtered liquid. It would be premature to assert here that this change did or did not occur through the agency of *carbonate* of lime; but supposing that carbonate of lime was the acting substance, we have a distinct reversal of the ordinary chemical laws: thus, for instance, we might under this presumption mix carbonate of ammonia with sulphate of lime, the result being an interchange of the acids and bases; the mixture then being incorporated with a soil, we should again have gypsum and carbonate of ammonia, the latter being combined in some way with the soil. Such a reaction would be quite possible supposing the power of the soil to arrest and combine with the carbonate of ammonia. It would indicate, however, that this power was one of great activity, since it was sufficient to reverse altogether the ordinary chemical laws. My object in dwelling upon this point is to show, that supposing the power under discussion to resemble that of charcoal and other porous substances for ammonia, and, further, granting that carbonate of ammonia, as possessing in part the gaseous character of the free alkali, was subject to the same law, then it would be quite conceivable that the different salts of ammonia should come under its influence by virtue of the transforming power of carbonate of lime in the soil. The law would then simply resolve itself into one of a physical character, affecting the ammonia and its carbonate directly, and the other salts by indirect action.

Highly interesting and important in both a theoretical and a practical point of view as this action of soils upon ammonia and its compounds would be if it went no further, it by no means comprehends the whole question, and we shall now proceed to detail experiments which render it necessary to modify if not altogether to abandon the notion that the absorption is of the nature of the gaseous condensation exhibited by charcoal and other porous bodies.

Absorption of Potash.

Experiment 43.—Caustic potash. Solution of caustic potash was thrown upon a 10-inch filter of Mr. Pusey's soil. The solution employed gave abundance of double chloride of platinum and potassium when treated with chloride of platinum; but the liquid, after percolation, contained no potash in any form, which had therefore been arrested by the soil.

Experiment 44.—Carbonate of potash. Mr. Huxtable's soil in a tube 18 inches long; through this a solution of carbonate of potash of unknown strength, but strongly effervescing with acid, and giving with platinum solution ready evidence of the presence of potash, was filtered; it came through in a few minutes. The filtered liquid did not effervesce with acids, and no indication of potash in it could be obtained. The experiments were tried comparatively with the solution before and after filtration, and the result was not in the least doubtful.

Experiment 45.—20 grains of carbonate of potash were dissolved in 8 ounces of water. The solution effervesced strongly with hydrochloric acid, and gave ready evidence of potash when treated by chloride of platinum. It was poured upon a filter-bed of Mr. Pusey's soil 10 inches in depth. When an ounce and a half had passed through the liquid was examined; to avoid any chance of error three separate quantities of the original and resulting liquids being tested comparatively: the results were very satisfactory, and proved the total separation of the carbonate of potash by the filtration.

In these last experiments we meet with the unexpected fact that potash and its carbonate, which in the liquid way form very few insoluble compounds, are, by a power inherent in soils, made insoluble and separated from water. It has just before been explained that the power of soils to separate ammonia from its salts, wonderful as that is, might have existed independently of any such action on the other bases, and might have been supposed to depend upon a physical law of condensation for ammonia and its carbonate as gaseous substances. That such is not the case, however, and that the action is of a purely chemical kind, is obvious from the last experiments, in which potash and its carbonate, both fixed substances, are separated from solution and detained in the insoluble form in a perfectly analogous way.

We shall now shortly state the experiments made with solutions of other potash salts.

Experiment 46.—Nitrate of potash. 100 grains of nitrate of potash were dissolved in 5000 grains of water (1 part in 50). The solution was passed through a filter-bed of 10 inches of Mr. Pusey's soil; it came through quickly, and contained no potash: nitric acid, however, was, by the proper tests, found to have passed in abundance, and existed as nitrate of lime in the filtered liquid.

Experiment 47.—A repetition of the last, with the same results.

Experiment 48.—A similar experiment with Mr. Huxtable's soil and muriate of potash. The filtered solution contained no potash, but in its place plenty of lime in the state of muriate.

Experiment 49.—A solution of sulphate of potash passed through Mr. Pusey's soil. The resulting liquid contained much sulphate of lime, but no potash.

The salts of potash, then, seem to obey precisely the same law as those of ammonia. So far as it has yet appeared the caustic alkali and its carbonate are in each case absorbed without change, whilst the other salts only part with their base, obtaining

lime in its stead, with which they come away in the liquid. We pass on now to salts of soda. It was thought unnecessary in this case to operate upon the caustic alkali, and the only solutions employed were the muriate and sulphate.

Experiment 50.—A solution of sulphate of soda, of unknown strength, but affording an abundant precipitate by nitrate of barytes, and strongly colouring the flame of a spirit-lamp, was passed through 10 inches of Mr. Pusey's soil. The solution, after filtration, contained much sulphate of lime, but it gave scarcely any yellow colour to the flame. The lime being precipitated by oxalate of ammonia, and the solution evaporated to dryness with subsequent heating of the residue, afforded a small portion of a salt which was probably soda, but the greater part of the soda of the salt employed had undoubtedly been detained by the soil.

Similar experiments were made with the sulphate of soda and white clay, and with muriate of soda (common salt) and Mr. Pusey's soil, and in both cases an absorption of the alkali was found to occur.

Absorption of Lime.—The experiments which have been described would quite lead us to expect that the ordinary salts of lime—the muriate, sulphate, nitrate, &c.—would in no degree be arrested by soils, but that their solutions would pass unchanged through the filters employed. It will be borne in mind, as has been before frequently stated, that the attraction of the soil is for the alkaline or earthy base, and not for the whole salt. But this attraction could not be gratified unless some other base were found to combine with the acid, for it is inconceivable that the strong mineral acids should be displaced by any compounds in the soil. We have seen that in all cases where a salt is filtered through the soil, the acid comes away in the liquid not in the free state, but combined with lime, which it has taken in exchange for its previous saturating base; nor can we for a moment suppose that the union of the acid with lime is a secondary and accidental circumstance, the absorption of the potash or ammonia first taking place, and the liberated acid subsequently meeting with lime and dissolving it. Whatever be the nature of the combination which occurs between the ammonia or potash and the soil, it cannot be doubted that it would readily be destroyed by any of the mineral acids, even in a dilute state. The combination of the soil with the base and of lime with the acid must be simultaneous, and unless the lime were present in the soil, and in the proper state too, no kind of change could occur. By these remarks it will, we hope, be made perfectly plain that the salts of lime will in no way be subject to the singular law which we are discussing. Lime is the saturating base provided for the exercise of this power upon salts of the other alkalis and earths, but for its own salts there is no provision. It does not, however, follow that solution

of caustic lime should not be arrested in the same way as caustic potash or ammonia is, for in these cases the action seems to be simple and direct. Accordingly we find that lime-water is entirely deprived of its lime by filtration through a soil, as shown by the following experiment:—

Experiment 51.—Lime-water of moderate strength was poured upon a mixture of white pottery clay with sand, forming a filter of 12 inches in depth. A considerable quantity of liquid passed without bringing through any portion of lime, either free or in combination.

Experiments 52, 53, *and* 54.—Similar experiments with lime-water and three different subsoil clays of the gault formation, obtained from Mr. Paine's land at Farnham. In all these cases a large quantity of lime was arrested.

For further illustrations of the power of soils to arrest free lime, see page 361.

Obviously, then, lime in the free state, uncombined, that is, with any acid, is detained by soils in much the same way as the other bases. I have reason, however, to think that the power to arrest lime is in quantity, at least, not at all in relation to the power to arrest other bases, and that indeed the combination with lime is a proof that the soil is not in the best condition for the detention of other alkaline and earthy bases. Leaving, however, this point for discussion at a much more advanced stage of our investigation, we will proceed to ascertain whether carbonate of lime is at all subject to removal from solution and filtration through soils. It has been seen, indeed, that the carbonates of potash and ammonia are arrested by the soil apparently as a whole—that is to say, neither the acid nor the base is found in the filtered liquid. This result may be viewed in two ways: either that the absorptive power of the soil exists equally for the carbonates and the caustic alkali; or, that the base being absorbed, the carbonic acid is, as in all the other salts, transferred to lime, and the carbonate of lime so formed is only absent from the filtered liquid on account of its insolubility in water. This second mode is by far the most probable, and, if true, would decide the question against *carbonate of lime* in the soil being the means of transformation—for, were it so, the filtration of carbonate of ammonia and potash through a soil should afford a corresponding quantity of bi-carbonate of lime in the resulting liquid, which is not found to be the case. But the stoppage of carbonates of potash and ammonia by the soil does not necessitate a similar retention of carbonate of lime, seeing that the latter exists when in solution only as the bi-carbonate of lime, that is to say, carbonate of lime dissolved by an extra dose of carbonic acid. To detain the carbonate of lime the soil must then be able to deprive it in some way of its extra carbonic acid. That soils have this faculty, the following experiments will demonstrate.

Absorption of Carbonate of Lime.

Experiment 55.—Carbonate of lime (chalk) was diffused through water, and a stream of carbonic acid gas passed into the liquid for some time; the solution was filtered through paper to clear it from the undissolved chalk, and was then passed through 12 inches of Mr. Pusey's soil. The filtered liquid was quite free from lime or carbonic acid.

Experiment 56.—A specimen of water from a limestone district containing upwards of 80 grains of salts of lime in the gallon (three-fourths of this quantity consisting of carbonate and the other of muriate and sulphate), was filtered through the same soil. The filtered liquid contained sulphate and muriate of lime in apparently undiminished quantity, but did not afford, upon evaporation, any appreciable quantity of carbonate.

Experiment 57.—A similar experiment with Thames water, the filtering medium being a mixture of white pottery clay and fine sand. Several gallons of water were filtered in this case through a filter-bed of about 4 lbs. of the above materials. With the exception of a little sulphate and muriate of lime, which salts are not amenable to the powers of the clay, the filtered water was free from lime; it did not contain a trace of carbonate. (For further experiments on carbonate of lime, see p. 362.)

These experiments, and they have been proved to be correct by frequent repetition, quite establish the fact that lime and its carbonate are liable to detention by soils with which these solutions come in contact. I have no doubt that the history of the absorption of carbonate as well as of caustic lime will prove totally different from, although intimately connected with, that of the other substances in question. But our attention is at present confined principally to the *facts*, and the explanation of those facts must in great part, at least, be reserved for further communications.

Absorption of Magnesia.

The base magnesia itself cannot form the subject of experiments in filtration, because it is insoluble, or nearly so, in water.

The carbonate of magnesia is, like carbonate of lime, insoluble in water, but soluble, like it, in water containing carbonic acid. The power of soils in arresting carbonate of magnesia has not been tried, but from the experiments on its other compounds now to be described there is no doubt that it would be the same as for carbonate of lime.

Experiment 58.—Sulphate of magnesia. 100 grains of sulphate of magnesia were dissolved in 10,000 grains of water (nearly $1\frac{1}{2}$ pint), forming a solution containing therefore 1 per cent. of this salt. This liquid was passed through a filter-bed of 10 inches of Mr. Pusey's soil; it percolated quickly, and gave, when tested, abundance of sulphate of lime. The lime, being precipitated by oxalate of ammonia, the solution was examined for magnesia, but it contained none.

Experiments 59 *and* 60.—Similar experiments with muriate and nitrate of magnesia, affording analogous results; the acids being in each case found in the filtered liquid in combination with lime.

Thus, then, it has been proved that for the bases of the salts of ammonia, potash, magnesia, and soda, the absorptive power of the soil is available either directly or through the agency of lime. It has further been proved that this property extends to the separation of lime and its carbonate from solution; whilst it has, so far as we can yet learn, no action upon the ordinary soluble salts of lime.

The compounds which are thus arrested form a most important part of the mineral ingredients of manure; but there is yet one mineral element of vegetable nutrition which is so very valuable, that we should learn with a certain amount of dissatisfaction its want of subjection to a law which cannot be regarded in any other light than as a direct impress of the wonderful hand of Providence. This substance is phosphoric acid, which, it is almost unnecessary to say in this place, is of vital consequence to vegetable existence. As an acid substance it could not obviously be subject to an action having reference only to bases; but owing to the insoluble condition of one of its salts, it is in a subsidiary but most perfect manner retained and preserved in the soil. Phosphate of lime is, like the carbonate, insoluble or nearly insoluble in pure water; therefore when an alkaline phosphate of potash or ammonia is brought in contact with the soil, the absorbing action of the latter for the potash or ammonia causes the phosphoric acid to combine at the same time with lime, forming a phosphate of lime, which from its insolubility is retained.

Phosphate of lime is, like the carbonate, soluble in carbonic acid water; and it is probable that this is the principal source or mode of supply of phosphoric acid to plants. The same action which enables a soil to remove carbonic acid from a solution of bi-carbonate of lime may also be expected to separate its solvent from phosphate of lime so dissolved. Such is actually the case, and thus the phosphoric acid of phosphate of lime is incidentally subject to the same law that serves for the preservation of the alkaline bases.

Again, phosphate of lime is soluble in an excess of phosphoric acid, which forms with it the acid or bi-phosphate of lime, which has become so valuable an accessory to turnip cultivation under the name of "superphosphate of lime." It would appear probable that the same action which in the cases just quoted separates carbonic acid from bi-carbonate of lime, and which is undoubtedly that of a base for an acid, should come into play in the case of bi-phosphate of lime; and it has been experimentally proved that soils *have* the power to arrest entirely the acid phosphate of lime. It is to be observed, however, that in this particular instance the newly observed action is not absolutely necessary to such a result, since the mere mixture of carbonate of lime

with the bi-phosphate would convert the whole of the phosphoric acid into an insoluble phosphate; but at the same time it seems to follow, from all that has been said, that a soil containing no portion of lime in the form of carbonate, would perfectly retain the phosphoric acid of superphosphate of lime.

These observations have preceded the account of the actual experiments, because, with a knowledge of the actions previously described, the results are only such as would with tolerable certainty have been predicted.

Absorption of Phosphoric Acid by Soils.

Experiment 61.—A filtering-jar was partially filled with Mr. Pusey's soil; it contained perhaps about 1 lb. of soil. Through this soil a solution of phosphate of soda was passed. About 10 oz. of the filtered liquid were collected and tested for phosphoric acid in comparison with the original solution. The latter gave abundance of pyrophosphate of magnesia, but no evidence of phosphoric acid could be obtained in the filtered liquid.

Experiment 62.—The ash of Peruvian guano (which is principally phosphate of lime) was dissolved in dilute sulphuric acid, an excess of the phosphate being employed. The solution was made clear by filtering through paper and was then thrown upon a filter-bed of soil similar to that employed in the last experiment. When 8 ounces of liquid had passed the solution was tested, but no phosphoric acid could be detected in it.

These experiments are quite sufficient to prove that phosphoric acid, though not subject to direct absorption by any ingredients of the soil, is yet indirectly retained by it.

On the Extent of the Power of Soils to absorb Ammonia, Potash, &c.—The experiments hitherto recorded speak only of the fact that ammonia, potash, magnesia, &c., are absorbed and rendered insoluble by soils—affording, however, indications of this power being very considerable, and in all probability abundantly sufficient for the preservation of the various salts from loss by washing of the soil. It seemed very important also to ascertain to what extent the property in question was exhibited in soils—whether it was the same for all soils—and whether, in the same soil, it was equal for the different alkaline bases. To obtain a solution of these questions required the employment of rigorous quantitative analysis; and although much remains to be done even in this department of the subject, the experiments which follow will, it is hoped, convey a very fair general notion of this property of soils. In entering upon this portion of the inquiry, it was soon found that the method of filtration, although extremely convenient in the earlier and preliminary experiments, could not be satisfactorily employed in determining the *amount* of absorptive power. However finely and uniformly a soil may be divided,

there is no security that in percolating it, when used as a filter, the liquid shall come in contact with every particle. The tendency to form channels by which the subsequent portions of the liquid would pass, leaving other parts of the filter comparatively unacted on, is greatly opposed to the chance of a satisfactory result being obtained by this method; and in addition to this primary difficulty, there are others which would occur to any person making such experiments, and which need not here be further discussed. It is obvious that the power of a soil to absorb and solidify various alkaline substances is independent of the accidental circumstances of filtration, and would be exhibited whether the soil or the solution were used in excess. If then we have a solution, say of ammonia of known strength, and that we mix with any given quantity of it a known weight of the soil to be examined, the quantity of ammonia in the liquid will be reduced by so much as the soil has absorbed. By examining the clear liquid after the soil has been allowed to fall to the bottom, we shall at once have the means of calculating what quantity of ammonia it has lost, and consequently what quantity the soil has taken up. In experimenting upon ammonia, which it is well known is very volatile, it was necessary to guard against loss during the time occupied in the experiment. After several attempts, a simple apparatus was contrived, by which the solution of ammonia and the soil could be left in contact for any length of time, and the clear liquid filtered off without the slightest exposure to loss. The ammoniacal solution, as it fell from the apparatus, was received in a small bottle containing a weighed quantity of hydrochloric acid, and the quantity to be employed in the subsequent operations could then be determined with perfect safety.

It will be thus seen that the plan adopted has been that of determining the quantity of base absorbed by that which the solution has lost. It does not appear that this method is open to much objection, and it is far preferable to the only other that could be resorted to—namely, the examination of the soil itself after subjecting it to the action of the different salts. Indeed, although this latter plan may seem at first sight the most simple and direct, it is upon closer inspection found to be quite inadmissible in most cases. Let us suppose that it is wished to ascertain the absorbent power of any soil for ammonia. After placing it in contact with a solution of this alkali, we require to dry it, in order, by burning it, to drive off the ammonia. What security is there that the act of drying will not drive off the ammonia? Then again, having surmounted this difficulty, we meet with another. It is to be expected that as this power exists in soils, it will manifest itself naturally, and every soil will more or less contain am-

monia, which would be added to the quantity absorbed in our experiment. It is true that this objection extends to the method adopted; and the absorption of ammonia in the instances which follow must be considered to represent less than the total extent of the power, since many, and no doubt all of them, are already in part saturated with those substances with which they have a tendency to combine; but it is plain that, supposing the direct examination suitable for ammonia, it would be impossible to adopt it for potash, magnesia, &c., which could only be separated from the soil that had absorbed them by means of mineral acids, which would at the same time dissolve out additional quantities of the same bases existing in the soil as ordinary ingredients of it. Under the circumstances, it is therefore plain that the *differential* method was the only one available; and the experiments that follow show that it is capable of very considerable accuracy.

In operating upon ammonia and its salts, it was necessary, in order to estimate the quantity of the alkali in the solution, and to separate it from salts of lime, &c., to distill the resulting liquid with potash. This distillation was effected in a small retort, having attached to its neck a tube with a bulb blown upon it. The mouth of the tube dipped into hydrochloric acid in a small bottle immersed in cold water, but all possibility of the liquid passing back into the retort was removed by the bulb on the tube. The retort was furnished with a small funnel, by which the materials were introduced. In order to ascertain that sufficient potash was used, a few drops of an infusion of sandal-wood were added to the liquid in the retort.

It has been thought necessary to describe the manner in which these distillations were made, because it is usually believed that it is impossible by distillation to estimate ammonia with very great accuracy. The analyses, however, which are here given, show that, with proper precautions, the method gives excellent results.

The acid solution of sal-ammoniac, produced by the distillation, was mixed with chloride of platinum, evaporated to dryness, treated with alcohol and ether in the usual way, and the resulting platinum salt dried and weighed.

The solution of ammonia that was employed for the experiments was the same as that mentioned before. All that was required was to employ a solution of manageable strength, and to ascertain exactly what that strength was. Two or three gallons of ammoniacal solution were made by mixing the strongest solution of ammonia with from fifty to sixty times its weight of water. The following analyses show the strength of this solution :—

Quantity of Ammonia in the standard solution.

	Grains of the Solution.		Platinum Salt.		Ammonia.		Per Cent.
1st Estimation—	163·41	gave	6·86	=	·5230	or	·3200
2nd Estimation—	210·70	gave	8·83	=	·6732	or	·3195
3rd Estimation—	208·94	gave	8·65	=	·6595	or	·3156
4th Estimation—	250·16	gave	10·39	=	·79213	or	·3166
5th Estimation—	275·33	gave	11·37	=	·8668	or	·3150

1st . . .	·3200	Mean, ·3173
2nd . . .	·3195	
3rd . . .	·3156	
4th . . .	·3166	
5th . . .	·3150	

The extreme latitude in these experiments only amounts to $\frac{5}{1000}$th of a grain of ammonia; and the mean, which is ·3173, may be safely taken as the true strength of the solution.

In making an experiment upon the extent of absorption of a soil for ammonia, a given quantity of the solution was weighed—care being taken to avoid exposure of it to the air, and to effect the different operations as rapidly as possible. The first experiment was made with Mr. Huxtable's loamy soil.

Experiment 63.—Mr. Huxtable's loamy soil dried at about 150° Fahr., and broken up till it passed a sieve of 40 holes to the inch; 760 grains; standard solution of ammonia, 1787 grains; well shaken and allowed to digest for two hours:—

	Grains.		Platinum Salt.		Ammonia.		Per Cent.
1st Distillation of the resulting Liquid—	193·12	gave	4·75	=	·36214	or	·1875
2nd Distillation—	389·73	gave	9·56	=	·7288	or	·1870

1st Result	·18750	per Cent.
2nd ,, ...	·18700	,,
Mean . . .	·18725	,,

100 grains of the original Solution contained	·31730	grains of Ammonia.	
100 grains of the resulting Solution contained	·18725	,,	,,
Loss by each 100 grains of Solution . .	·13005	,,	,,

The whole quantity of solution (1787 grains) would, therefore, have lost 2·3239 grains, which has obviously been absorbed by the 760 grains of soil.

Thus, every 100 grains of soil has absorbed or united with ·3083 grain of ammonia.

According to this first experiment, a light loamy soil absorbs from solution ·3083 per cent. of its weight of free ammonia.

Experiment 64.—Mr. Huxtable's light soil, with standard solution of ammonia.

4082 grains of solution of ammonia }
456 grains of the dry soil } Digested together for two hours.

1st Distillation of the Product—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
447·18	gave	15·98	=	1·2183	or	·2724

2nd Distillation—

212·09	gave	7·64	=	·58274	or	·2746

3rd Distillation—

368·10	gave	12·69	=	·96748	or	·2628

The two first estimations agree very nearly, and will perhaps be more correct than the third :—

Taking the 1st and 2nd, we have—

1st Estimation . .	·2724	per Cent.
2nd ,, . .	·2746	,,
Mean . .	·2735	,,

100 grains of the original Solution contained	·3173	grains of Ammonia.	
100 grains of the resulting Solution contained	·2735	,,	,,
Loss by each 100 grains of Solution . .	·0438	,,	,,

The whole quantity of solution (4082 grains) would therefore have lost 1·7879 grains of ammonia, which has been absorbed by 456 grains of soil; making the absorption in this experiment ·3921 for every 100 grains of soil.

Experiment 65.—Mr. Huxtable's soil, and standard solution of ammonia, as before :—

Solution 3988 grains }
Soil 594 grains } Digested for two hours.

1st Distillation of the Product—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
180·36	gave	6·26	=	·47726	or	·2646

2nd Distillation—

234·66	gave	8·14	=	·62057	or	·2644

3rd Distillation—

230·92	gave	8·08	=	·61525	or	·2664

1st Estimation	·2646	per Cent.
2nd ,, ...	·2644	,,
3rd ,, ...	·2664	,,
Mean . .	·2651	,,

100 grains of the original Solution contained	·3173	grains of Ammonia.	
100 grains of the resulting Solution contained	·2651	,,	,,
Loss by each 100 grains of Solution . .	·0522	,,	,,

The whole quantity of solution (3988 grains) would therefore have lost 2·0817 grains of ammonia, which, being absorbed by 594 grains of soil, makes the absorption by each 100 grains of soil to be ·3504.

Experiment 66.—Mr. Huxtable's soil, and standard solution of ammonia. The quantities in this experiment were exactly as in the last, namely :—

Solution 3988 grains } Digested, however, for a shorter period—
Soil . 594 ,, } namely, half an hour.

1st Distillation of the Product—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
158·02	gave	5·49	=	·41855	or	·2649

2nd Distillation—

146·68	gave	5·14	=	·39187	or	·2671

3rd Distillation—

179·29	gave	6·26	=	·47726	or	·2662

1st Distillation . . .	·2649	per Cent.
2nd ,, . . .	·2671	,,
3rd ,, . . .	·2662	,,
Mean . . .	·2661	,,

100 grains of the original liquid contained .	·3173	grains of Ammonia.
100 grains of the resulting liquid contained	·2661	,, ,,
Loss by each 100 grains of Solution . .	·0512	

The whole quantity of solution (3988 grains) would therefore have lost 2·0418 grains of ammonia, which, being absorbed by 594 grains of soil, makes the absorption ·3438 per cent.

In the last experiment the absorption, with corresponding quantities of soil and solution, was found to be ·3584 per cent.; the difference between the two results is, therefore, only to the extent of $\frac{6}{1000}$ of a grain, and would have been much less if the mean of the 1st and 3rd of the last estimations of ammonia had been taken as the true result.

In order to ascertain whether any difference in the amount of the absorption would be caused by longer contact of the soil with the solution, the quantity remaining from the last experiment was left to digest upon the soil for fourteen or sixteen hours longer, the bottle being repeatedly shaken. The following result was then obtained by examining the solution :—

4th Distillation—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
145·49	gave	4·93	=	·3758	or	·2652

This result is almost identical with that obtained when the liquid had only been digested with the soil for half an hour; and also with the previous one, in which the digestion had been continued for two hours. It is obvious, therefore, that a longer duration of the experiment than half-an-hour is quite unnecessary, as the full effect occurs within that time.

It has already been shown (experiments 8, 9, 10, and 11) that a great amount of absorption takes place almost instantaneously, and, from the experiments that have just been described, there is little doubt that the perfect union of the soil with the alkaline substance is as rapidly produced as the ordinary combination of an acid and a base. It will be sufficient to call attention to this point

at the present time, leaving it to a later part of the paper to show its practical bearing upon the question of manuring and other agricultural operations.

We shall have occasion to describe presently other experiments made with the solution of free ammonia and different soils. In order, however, that the reader may follow as closely as possible the steps of the operator—seeing the object to which his experiments were directed, understanding his difficulties, and appreciating the means by which the results were successively developed—we shall now relate the experiments which were made with one of the salts of ammonia, instead of the free alkali itself.

Muriate of ammonia was chosen for this purpose, and in order that the trials might bear some comparison with those before described, the strength of the liquid was so regulated that the quantity of ammonia might be somewhat about ·3 per cent.

Pure sal-ammoniac was dissolved in about 100 times its weight of water, a large stock of the liquid being prepared for use; the following analyses show its actual strength:—

1st Distillation of Standard Solution of Muriate of Ammonia—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
119·21	gave	4·61	=	·35146	or	·2948

2nd Distillation—

185·91	gave	7·31	=	·5573	or	·2997

3rd Distillation—

227·61	gave	9·21	=	·70445	or	·3095

4th Distillation—

165·72	gave	6·70	=	·5108	or	·3088

1st Experiment	·2948 per Cent.
2nd ,, ...	·2997 ,,
3rd ,, ...	·3095 ,,
4th ,, ...	·3088 ,,

The first of these determinations is evidently below the truth; and as the other three agree as closely as could be expected, it will be safe to take the mean of these results as the true proportion:—

The standard solution of muriate of ammonia contains, therefore, ·3060 per cent. of ammonia.

The first experiment was with Mr. Huxtable's soil; and, in order to make it compare with those in which the free ammonia was employed, similar quantities of the soil and solution were taken:—

Experiment 67.—Mr. Huxtable's light soil, and standard solution of muriate of ammonia—

Solution 3988 grains}
Soil . 594 ,, } Digested for two hours.

1st Distillation of the resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
82·83	gave	5·95	=	·4536	or	·2481

2nd Distillation—

225·12	gave	6·05	=	·4612	or	·2049

3rd Distillation—

238·78	gave	8·31	=	·6335	or	·2653

1st Experiment . . .	·2481 per Cent.
2nd ,, . . .	·2049 ,,
3rd ,, . . .	·2653 ,,

These results do not accord by any means so satisfactorily as might be wished; but taking the 1st and 3rd, which only differ from each other by $\frac{15}{1000}$ths, we obtain a mean of ·2567 for the strength of the resulting liquid.

100 grains of the original Solution contained	·3060	grains of Ammonia.
100 grains of the resulting Solution contained	·2567	,, ,,
Loss by each 100 grains of Solution . .	·0493	

The whole quantity of liquid (3988 grains) will therefore have lost 2·066 grains of ammonia, which have been absorbed by 594 grains of soil. The absorption by 100 grains of soil is consequently ·3478 grain.

This result is very interesting. It will be remembered that with the same relative quantities of soil and solution, when the *free ammonia* was employed, the absorption was ·3438 per cent.

With the muriate it is ·3478 per cent.: a correspondence which is quite as close as could reasonably be expected when proper allowance is made for errors of experiment. It thus appears that the power of the soil to absorb ammonia is in this instance the same, whether the alkali be in the free state or in combination with an acid.

In the preliminary experiments we found reason to believe that the decomposition of an ammoniacal salt and the retention of the ammonia were attended with the production of an equivalent quantity of a salt of lime, which remained in the liquid. If such were the case, the muriatic acid of the sal-ammoniac, not being in any way affected by the action of the soil, but simply transferred from that salt to lime, would be found in the resulting in the same quantity as in the original liquid. The following experiment proves that this view is perfectly correct:—

Experiment 68.—Estimation of muriatic acid (chlorine) in the original and resulting solutions:—

Original Solution—

Grains.		Chloride of Silver.		Chlorine.		Per Cent.
346·67	gave	9·00	=	2·2418	or	·6417

Resulting Liquid—

317·48	gave	8·17	=	2·019	or	·6361

100 grains of the original Solution contained	·6417	grains of Chlorine.
100 grains of the resulting Solution contained	·6361	,, ,,

A result which may be considered as identical in the two cases.

Thus, it is evident that when a soil acts upon a salt of ammonia it abstracts only the alkali, the acid being transferred to

lime, forming a corresponding salt of that base, which is not retained by the soil.

The next experiment was designed to determine the absorptive power of a natural clay; the white pottery clay, before described, being employed. It may be worthy of notice that attempts which were made to find the power which this clay possesses for the solution of free ammonia entirely failed, from the impossibility of separating either by subsidence or filtration the finely divided clay from the solution; the liquid remained turbid, and could not be obtained by any process sufficiently clear for a satisfactory experiment. On the other hand, the clay was found to subside quickly and perfectly from the solution of the muriate; the apparatus which was used in the first trials with ammonia was less necessary in operating with the fixed salts of this base; but as it prevented any evaporation during the process, its use was retained :—

Experiment 69.—Pipe-clay and muriate of ammonia. Pipe-clay (plastic clay) dried at between 150° and 200°, and passed through a sieve of 40 holes to the inch.

Solution of Muriate	4000 grains	Digested for two hours.
Clay	400 ,,	

1st Distillation of the resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
151·57	gave	5·39	=	·41093	or	·2711
2nd Distillation—						
215·27	gave	7·83	=	·59696	or	·2773
3rd Distillation—						
196·39	gave	7·32	=	·5580	or	·2842

1st Estimation	·2711 per Cent.
2nd ,, ...	·2773 ,,
3rd ,, ...	·2842 ,,
Mean of the 3 Experiments	·27753 ,,

100 grains of the original Solution contained	·3060 grains of Ammonia.
100 grains of the resulting Solution contained	·27753 ,, ,,
Loss by 100 grains of Solution . . .	·02847

The whole quantity of solution (4000 grains) will therefore have lost 1·1388 grains of ammonia, which is absorbed by 400 grains of soil, making the absorption by 100 grains of soil ·2847.

It will be seen by experiments before given and by others that follow (63, 64, 65, 70, 71, and 72), that the *rate of absorption* was, in some way, evidently regulated by *the strength* of the solutions, and the relative quantities of these latter and of the soils employed. This fact must be borne in mind in judging of the absorptive power of the clay, according to the last experiment; and although it is certain that the power of this natural clay to absorb ammonia is less than that of some cultivated soils

like Mr. Huxtable's, it will be better to defer the comparison till after the experiments have been recounted. In the preliminary experiments we were led to believe that the addition of chalk to a soil did not increase its absorbent power: in other words, that the *carbonate* of lime either was unnecessary to the exhibition of the absorptive faculty; or that, if necessary, it existed in the soils examined in sufficient quantity. The experiment now to be described throws much light on this point:—

Experiment 70.—Pipe-clay, muriate of ammonia, and chalk—

Solution of Muriate	4000 grains.
Pipe-clay	400 ,,
Chalk	50 ,,

The pipe-clay and the chalk were well mixed in a mortar, having both previously passed through a sieve of 40 holes to the inch.

The materials were digested together for two hours.

1st Distillation of the resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
245·59	gave	8·93	=	·68082	or	·2772

2nd Distillation—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
180·17	gave	6·58	=	·50165	or	·2784

1st Experiment . . .	·2772 per Cent.
2nd ,, . . .	·2784 ,,
Mean	·2778 ,,

100 grains of the original Liquid contained	·3060	grains of Ammonia.
100 grains of the resulting Liquid contained	·2778	,, ,,
Loss by each 100 grains of Solution .	·0282	,, ,,

The whole quantity of solution (4000 grains) has therefore lost 1·1280 grains of ammonia, which has been absorbed by 400 grains of clay, making the absorption by 100 grains of clay to be ·2820.

The quantity of ammonia absorbed from the muriate by the clay alone was ·2847 per cent.

When chalk is added, the absorption is found to be ·2820 per cent., which, allowing for necessary errors of experiment, is obviously the same quantity. Now, it will be remembered (see Analysis, p. 320), that this clay, although containing lime, does not give a perceptible indication of the presence of the base in the state of carbonate. But notwithstanding this, we find that the addition of carbonate of lime to the clay in no degree increases its power to combine with ammonia. This is one of the best instances that could be adduced in proof of the belief that carbonate of lime is not an agent—or perhaps it would be better said, not a direct agent—in their transformation.

In the last experiment it will be observed that, in order to give a greater uniformity and a facility of comparison to the results, the quantity of absorbing substance was made to bear a definite relation to the solution. It was obvious, however, at this time

that the results would be made much more accurate if the unavoidable errors of experiment were distributed over a larger quantity of the soil. Thus, for instance, in the last experiments an error of $\frac{1}{1000}$th in the determination of the ammonia, is magnified ten times, or becomes an error of $\frac{1}{100}$ on the per-centage absorption of the soil. Those who are acquainted with chemical operations will understand how difficult it is in such a case as the distillation of ammonia to guard against so small a deviation, and will appreciate the accuracy with which it was necessary to conduct the experiments if results of any value were to be obtained. To diminish as far as possible the sources of error, it seemed advisable to increase the quantity of soil in relation to the liquid, and the following experiments were made principally with this view:—

Experiment 71.—Pipe-clay and muriate of ammonia:—

Standard Solution of Muriate of Ammonia	4000 grains	Digested together for two hours.
Pipe-clay (passed through a sieve of 40 holes to the inch) . .	1000 ,,	

1st Distillation of the resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
168·19	gave	5·60	=	·42686	or	·2538

2nd Distillation—

170·01	gave	5·61	=	·42770	or	·2543

1st Experiment	·2538 per Cent.
2nd ,, ...	·2543 ,,
Mean of the 2 Experiments	·25405 ,,

100 grains of the original Liquid contained .	·30600 grains of Ammonia.
100 grains of the resulting Liquid contained	·25405 ,, ,,
Loss by 100 grains of liquid	·05195 ,, ,,

The loss by the whole liquid (4000 grains) will therefore be 2·0780 grains, which being absorbed by 1000 grains of clay, makes the absorption ·2078 per cent.

In the next experiment the relative proportion of clay is still further increased:—

Experiment 72.—Pipe-clay and muriate of ammonia:—

Standard Solution of Muriate	4000 grains	Digested for two hours.
Pipe-clay	2000 ,,	

1st Distillation of the resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
176·42	gave	4·65	=	·35452	or	·20095

2nd Distillation—

178·17	gave	4·91	=	·37434	or	·2101

1st Experiment . .	·20095 per cent.
2nd ,, . .	·21010 ,,
Mean . . .	·20552 ,,

100 grains of the original Liquid contained	·3060	grains
100 grains of the resulting Liquid contained	·2055	,,
Loss by each 100 grains of the liquid	·1005	,,

The whole quantity of liquid (4000 grains) will therefore have lost 4·020 grains of ammonia, which has been absorbed by 2000 grains of clay. The absorption by the clay is consequently ·2010 per cent.

It will be seen from the experiments just described that the absorptive property of the clay is not the same under all circumstances. Thus, when with the solution of muriate of ammonia $\frac{1}{10}$th of its weight of clay was digested, the absorption was ·2847 per cent. When the quantity of clay was increased to one half the weight of the solution, the per-centage absorption is reduced to ·2010, or little more than two-thirds. The intermediate relation, or where the clay is to the solution as 1 to 4 (being in the other instances as 1 to 10, and 1 to 2), gives only a slightly increased absorption over the last; and it may be assumed that a further increase of the proportion of the soil would not, beyond this point, materially diminish the amount of ammonia which a given weight of the soil would remove from solution.

I am unable at the present time to offer a satisfactory explanation of this circumstance, and only allude to it in order to show that be the absorbent substances in the soil what they may, it would seem necessary to isolate them, and study their properties in a less complicated condition, if we wish to make material progress in the knowledge of those properties as naturally exhibited in the soils themselves.

By employing a comparatively large quantity of soil in relation to the liquid, we have in the last experiments much reduced the liability to error. A deviation from the truth in the estimation of the strength of the liquid, is in this way only doubled when referred to the soil, instead of increased, as it was before, ten or twelve times. In the succeeding experiments these quantities are therefore uniformly employed.

The next experiment shows the effect of burning upon the absorptive powers of a clay:—

Experiment 73.—Pipe-clay dried was made to pass through a sieve of 40 holes to the inch; a quantity of it was then placed in a covered Hessian crucible and strongly heated in the laboratory furnace for two hours.

Owing to the cohesion of the particles produced by the heat, it was found that this burnt clay would subside from a solution of free ammonia, which was accordingly used.

Burnt pipe-clay and ammonia—

Standard solution of Ammonia	4000 grains	Digested for two hours.
Burnt Clay	2000 ,,	

1st Distillation of the resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
229·63	gave	7·74	=	·59048	or	·2571

2nd Distillation—

194·04	gave	6·51	=	·49577	or	·2555

1st Experiment	·2571	grains.
2nd „	·2555	„
Mean	·2563	„

100 grains of the original Liquid contained . .	·3173	Ammonia.
100 grains of the resulting Liquid contained . .	·2563	„
Loss by 100 grains	·0610	

The whole quantity of liquid (4000 grains) will therefore have lost 2·440 grains of ammonia, which has been absorbed by 2000 grains of burnt clay, making the absorption ·1220 per cent.

It was found in a previous instance (Expt. 66 and 67) that the absorption by a soil was the same for ammonia in the free state or as muriate. It is, therefore, fair to assume that the experiment just described would have afforded a corresponding result had the muriate of ammonia been substituted for the other solution. We see, then, that burning the clay has had the effect of diminishing its absorptive power by about one half.

With the view of deciding whether the alteration of the property of the clay is reduced in proportion to the extent of the burning, an experiment was made upon tobacco-pipes broken and sifted. It was found that the tobacco-pipe, when sifted through the sieve of 40 holes to the inch, would not subside from the solution of free ammonia, and it became accordingly necessary to employ the muriate:—

Experiment 74.—Tobacco-pipe powdered, muriate of ammonia, and chalk:—

Standard Solution of Muriate of Ammonia	4000 grains.
Pipe-dust	2000 „
Powdered Chalk	200 „

The chalk and powdered pipes were mixed in a mortar and digested with the muriate for more than 24 hours.

1st Distillation of the resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
292·21	gave	11·07	=	·84397	or	·2888
2nd Distillation—						
209·68	gave	7·90	=	·6023	or	·2872

1st Experiment . . .	·2888	per Cent.
2nd „ . . .	·2872	„
Mean	·2880	„

100 grains of the original Liquid contained .	·3060	grains of Ammonia.
100 grains of the resulting Liquid contained	·2880	„ „
Loss by each 100 grains of Solution .	·0180	„ „

The whole quantity of solution (4000 grains) had lost ·7200 of ammonia, which being absorbed by 2000 grains of pipe-dust, makes the absorption by the latter ·0360 per cent.

The power of *thoroughly* burnt clay to absorb ammonia is therefore very small—indeed *so* small that it would be unsafe to found our belief that such a power actually exists upon these experiments, however accurate they may appear. At the same time it will be recollected that, in operating upon a filter-bed of the same material, there appeared to be a diminution of the strength of the liquid, and consequently an absorption of the ammonia by the filtering medium. There can, however, be no doubt that the power of a clay is greatly diminished by burning; that it is not destroyed, but only reduced to one-half by a very considerable heat, is ample proof that the absorptive faculty does not reside in any organic or other compounds destructible by a moderate temperature.

The chalk was added in the last experiment in order that nothing might be wanting to the absorption of ammonia by the powdered pipe in case the power was possessed by it. We have before, however, seen reason to believe that carbonate of lime is not necessary in any case.

Tobacco-pipes, when broken up and sifted through a fine sieve, gave, as before stated, a powder which would not separate from a solution of ammonia, although it subsided perfectly from the muriate. By the use of two sieves, one of 20 and the other of 40 holes to the inch, it was found quite easy to obtain a powder which readily separated from ammonia, and offered a means of examining the action of highly burnt clay upon the free alkali in solution.

Experiment 75.—Powdered tobacco-pipes and solution of ammonia. Powdered tobacco-pipe was passed through a sieve of 20 holes to the inch; it was then thrown on another sieve of 40 holes; only that portion being used for the experiment that was detained by the sieve. This was further cleansed from adhering powder by being washed in distilled water, and then perfectly dried. Of course in this form it readily subsided from a liquid.

Standard Solution of Ammonia	4000 grains	Digested for two hours.
Powdered Pipe	2000 ,,	

1st Distillation of the resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
352·50	gave	13·64	=	1·0406	or	·2924

2nd Distillation—

175·69	gave	6·73	=	·51309	or	·2920

1st Experiment	·2924 per Cent.
2nd ,, ...	·2920 ,,
Mean	·2922 ,,

100 grains of the original Liquid contained .	·3173 grains of Ammonia.
100 grains of the resulting Liquid contained	·2922 ,, ,,
Loss by each 100 grains of Solution . .	·0251 ,, ,,

The whole quantity of solution (4000 grains) will have lost therefore ·1004 grains, which has been absorbed by 2000 grains of powdered pipe, making the absorption ·0502 per cent.

The powder of tobacco-pipes absorbed from the muriate ·0360 per cent.; from the solution of free ammonia it absorbs ·0502 per cent., or slightly more. I have before said, however, that it would be unsafe to press for distinctions so slight as this; and all that can be fairly said is, that whether from the muriate or free ammonia, the absorption by powdered pipe is very small, and probably equal for the two solutions when of corresponding strength.

The experiment which follows exhibits a result not exactly in unison with the principle which seemed, in some sort, fixed by previous experiments: that is to say, that the absorption of ammonia is equal for solutions of the same strength, whether the free alkali or one of its salts be used. I record the experiment as it was made, feeling convinced that whatever now appears contradictory in it will, by further researches, be cleared up—if not to the establishment of the principle, at least to that of the truth:—

Experiment 76.—Mr. Pusey's soil and ammonia:—

Standard Solution of Ammonia	4000 grains	Digested for two hours.
Mr. Pusey's Soil	2000 ,,	

1st Distillation of the resulting Liquid—

	Grains.		Platinum Salt.		Ammonia.		Per Cent.
	230·46	gave	7·14	=	·54435	or	·2362
2nd Distillation—							
	272·76	gave	8·71	=	·66405	or	·2134

1st Experiment . . .	·2362 per Cent.
2nd ,, . . .	·2434 ,,
Mean . . .	·2388 ,,

100 grains of the original Solution contained	·3173 grains of Ammonia.
100 grains of the resulting Solution contained	·2388 ,, ,,
Loss on 100 grains of Liquid . . .	·0785 ,, ,,

The whole quantity of liquid will have lost 3·140 grains of ammonia, which has been absorbed by 2000 grains of soil—making the absorption ·1570 per cent.

Experiment 77.—Mr. Pusey's soil and muriate of ammonia,—

Standard Solution of Muriate	4000 grains	Digested for two hours.
Mr. Pusey's Soil . . .	2000 ,,	

1st Distillation of the resulting Liquid—

	Grains.		Platinum Salt.		Ammonia.		Per Cent.
	319·02	gave	9·43	=	·71894	or	·2059
2nd Distillation—							
	244·91	gave	6·73	=	·51309	or	·2095

1st Experiment	·2059 per Cent.	
2nd ,, ...	·2095 ,,	
Mean . . .	·2077 ,,	

100 grains of the original Liquid contained	·3060 grains of Ammonia.	
100 grains of the resulting Liquid contained	·2077 ,, ,,	
Loss by 100 grains of Liquid . . .	·0983 ,, ,,	

The whole quantity of liquid has therefore lost 3·932 grains of ammonia, which is absorbed by 2000 grains of soil—making the absorption ·1966 per cent.

According to these experiments, every 100 grains of Mr. Pusey's soil absorbs from free ammonia ·1570 grains of ammonia; whilst from the muriate it absorbs ·1966, or considerably more. If the result had been the other way—that is, if the soil had absorbed more from the solution of the free alkali than from that of its salt, it would have been believed that the necessary circumstances for the decomposition of that salt were wanting. But it is difficult to understand the result as it stands. Future experiments may clear up the difficulty; but in the mean while we must suppose that, whilst some soils have an equal absorption for free ammonia and its salts, others may possess the property in a different degree for those different conditions of the alkali; and this supposition is borne out by other experiments, to be presently described. The following experiment on the extent of absorption of different soils for ammonia will find its proper place here :—

Experiment 78.—Mr. Huxtable's soil and muriate of ammonia.

Standard Solution of Muriate of Ammonia	4000 grains	Digested for two hours.
Mr. Huxtable's Soil	2000 ,,	

1st Distillation of the Resulting Liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
270·76	gave	6·71	=	·51157	or	·1889

2nd Distillation—

245·47	gave	6·01	=	·45820	or	·1866

1st Experiment	·1889 per Cent.
2nd ,, ...	·1866 ,,
Mean	·1877 ,,

100 grains of the original Liquid contained .	·3060 grains of Ammonia.
100 grains of the resulting Liquid contained	·1877 ,, ,,
Loss by each 100 grains of Solution . .	·1183 ,, ,,

The whole quantity of liquid will have lost 4·732 grains of ammonia, which has been absorbed by 2000 grains of soil—making the absorption ·2366 per cent.

The absorption by pipe-clay with similar quantities was ·2010 per cent.; so that, although a soil like that of Mr. Huxtable's may contain scarcely half of its weight of the absorbing sub-

stance, the clay, it yet may possess a greater power, weight for weight, than the pure clay itself.

The following experiment is of interest, as showing that the power of clay to absorb ammonia is not due to free alumina or to any other substances which are soluble in acids.

The white pottery clay was boiled for two hours in strong hydrochloric acid, the acid being further left in contact with it for twenty-four hours, at the expiration of which time the clay was frequently washed with pure water till all trace of the acid was removed: the clay was then dried.

Experiment 79.—Muriate of ammonia and acid-treated clay:—

Standard Solution of Muriate of Ammonia	4000 grains	Digested together for two hours.
Acid-treated Clay	2000 ,,	
Powdered Chalk	200 ,,	

1st Distillation of the resulting solution—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
229·48	gave	6·49	=	·4947	or	·2156

2nd Distillation—

276·38	gave	7·75	=	·5908	or	·2137

1st Analysis	·2156 per Cent.
2nd ,, ...	·2137 ,,
Mean	·2146 ,,

100 grains of the original solution contained .	·3060 grains of Ammonia.
100 grains of the resulting solution contained .	·2146 ,, ,,
Loss by 100 grains	·0914 ,, ,,

The whole quantity (4000 grains) will therefore have lost 3·656 grains of ammonia, which has been absorbed by 2000 grains of clay, making the absorption 1·828 per cent.

The absorptive power of the clay in its natural state was ·2010, so that by boiling in a strong acid we have caused only a very slight diminution of this power. Chalk was added to the materials in this experiment, in case the treatment with acid should so far have removed the lime as to destroy the power of the clay to decompose the salts of ammonia.

Another experiment was made with this acid-treated clay and muriate of ammonia, *without* the addition of chalk.

Experiment 80.—Acid-treated clay and muriate of ammonia:—

Muriate of Ammonia	4000 grains	Digested for two hours.
Acid-treated Clay	2000 ,,	

1st Distillation of the resulting liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
250·99	gave	8·03	=	·6122	or	·2439

2nd Distillation—

249·09	gave	7·958	=	·6061	or	·2433

1st Experiment	·2439	per Cent.
2nd ,, ...	·2433	,,
Mean	·2436	,,

100 grains of the original Solution contained .	·3060	grains of Ammonia.
100 grains of the resulting Solution contained .	·2436	,, ,,
Loss by 100 grains	·0624	,, ,,

The loss by the whole quantity (4000 grains) is consequently 2·496 grains, which has been absorbed by 2000 grains of clay, or at the rate of ·1248 per cent.

It would seem, from this last experiment, that carbonate of lime is capable, under certain circumstances, of assisting the absorptive property of clay.

Obviously, the acid-treated clay contains lime, or it could not decompose the muriate of ammonia at all, and in the analysis given at page 320 it will be seen that a certain quantity of lime exists in it in a state of insolubility in acids. If, however, carbonate of lime is in any case really conducive to the absorptive action of clay, it would seem more rational to suppose that it acts *indirectly*, that is to say, that it yields lime to the soil, and thus fits the latter for the decomposition of alkaline salts.

Experiment 80 (*a*).—A subsoil clay from Cornwall (coloured red by oxide of iron), and muriate of ammonia:—

Solution of the Muriate of Ammonia .	4000 grains	Digested for 24 hours.
Dry Clay	2000 ,,	

1st Distillation of the resulting liquid—

Grains.		Platinum Salt.		Ammonia.		Per Cent.
276·43	gave	9·63	=	·7342	or	·2655

2nd Distillation—

279·50	gave	9.71	=	·7403	or	·2648

1st Experiment	·2655	per Cent.
2nd ,, ...	·2648	,,
Mean	·2657	,,

100 grains of the original Solution contained .	·3060	grains of Ammonia.
100 grains of the resulting Solution contained .	·2651	,, ,,
Loss by 100 grains	·0409	,, ,,

The whole quantity (4000 grains) will have lost 1·636 grains, which has been absorbed by 2000 grains of clay, or at the rate of ·0818 per cent.

Other experiments were made with different soils and solutions of ammonia and its muriate; but as the results afford no fresh information, and can only become of value when an insight into the law upon which these differences depend shall have been obtained, it will be better to proceed with the other branches of the subject.

It becomes now necessary to describe the experiments that have been made with potash and its salts.

The first solutions that were employed were made of such strength as to compare as nearly as might be with the solutions of free ammonia and its muriate. At the time of commencing the potash experiments I believed (as I still do) that the property of the soil to unite with alkaline bases was of the nature of other chemical conbinations, and that consequently the different bases would be absorbed in the relation of their combining proportions. Thus the quantity of a soil which would absorb 17 parts of ammonia might be expected to unite with 47 parts of potash, with 31 parts of soda, and 20 parts of magnesia, these being the quantities which would respectively combine with a given weight of sulphuric or muriatic acid.

Nitrate of potash was the salt of this alkali employed in the experiments.

Pure crystallized nitrate of potash was dissolved in distilled water, the quantities of each being so arranged that the proportion of potash should be, equivalent for equivalent, as nearly as possible the same as in the solution of muriate of ammonia.

An analysis of the solution gave the following result:—

Grains.		Double Chloride of Platinum and Potassium.		Potash.		Per Cent.
278·02	gave	11·89	=	2·2951	or	·8255

To correspond with the muriate of ammonia this solution should contain ·8460 per cent. of potash; the resemblance, however, appeared sufficiently close for the purposes of the experiment, and the solution was consequently employed.

The following is an experiment with the solution of nitrate of potash and the white pottery clay.

Experiment 81:—

Standard solution of nitrate of potash	4000 grains	Digested together at the ordinary temperature for several hours.
White clay	2000 ,,	

The resulting solution was treated successively by hydrate of barytes and carbonate of ammonia in the usual way, to remove lime and any substances besides potash, which might have been dissolved.

1st Determination of Potash in the resulting Liquid—

Grains.		Platinum Salt.		Potash.		Per Cent.
289·67	gave	9·22	=	1·779	or	·6144

2nd Determination—

254·46	gave	7·91	=	1·5268	or	·6000

1st Experiment . . .	·6144	per Cent.
2nd ,, . . .	·6000	,,
Mean . . .	·6072	,,

100 grains of the original Solution contained	·8255	grains of Potash.
100 grains of the resulting Solution contained	·6072	,, ,,
Loss by each 100 grains of Solution .	·2183	,, ,,

The whole quantity of solution (4000 grains) would therefore have lost 8·732 grains of potash, which has been absorbed by 2000 grains of clay, making the absorption to be ·4366 per cent.

As was expected, the quantity of potash removed from solution by a given weight of the clay is here considerably greater than that of ammonia under similar circumstances. From the muriate of ammonia ·2010 per cent. was absorbed by the clay; the absorption of potash is as above, ·4366, or more than double. Still the relation of equivalent for equivalent is not attained here, for to equal ·2010 per cent. (the quantity of ammonia) potash to the amount of ·5568 should have been removed by 100 grains of the clay.

I am inclined to think that by further experiments the cause of this aberration will be satisfactorily made out, and that it in all probability depends upon a solubility of the compounds which are formed in the excess of the salts employed.

In the filtration of a salt of potash or ammonia through clay or through a soil, we examine the liquid that first passes, and can discover no trace of the salt employed. If our observation be correct, it is evident that the new compounds formed in the soil are not in any degree soluble in *pure water*, or we should have some portion of the potash or ammonia in the solution. In this method of making the experiment we have evidently the soil *in excess*, but when the soil or clay is digested in a solution containing more of the alkali than it can take up, the compounds formed in it, whatever they may be, are exposed to the action of an excess of *the saline solution*, in which they may quite possibly be, to a certain extent, soluble. The character of the resulting solution would therefore be modified by the introduction, to a greater or less extent, of the new compounds.

The clearing up of this question, as of many others connected with the subject, can hardly be expected from an examination of the heterogeneous compounds with which we have to deal in soils and clays, but it may confidently be expected to follow from the experiments which are being made to isolate and produce artificially the particular ingredients of the clay to which the power in question is supposed to be due.

In the succeeding experiments a somewhat stronger solution of potash was employed: nitrate of potash was dissolved in water until by repeated analysis and additions of the salt or of water the solution was made to contain, as nearly as might be, 1 per cent. of potash. The following analyses give the exact strength of this solution:—

1st Analysis—

Grains.		Platinum Salt.		Potash.		Per Cent.
233·97	gave	12·17	=	2·349	or	1·0040

2nd Analysis—

173·98	gave	9·03	=	1·743	or	1·0018

1st Experiment . .	1·0040	per Cent.
2nd ,, . .	1·0018	,,
Mean . . .	1·0029	,,

It would be hardly possible to obtain a solution more accurately representing 1 per cent. of potash than the above.

Experiment 82.—Solution of nitrate of potash (containing 1 per cent. potash) and white clay—

Solution 4000 grains } Digested for 24 hours, with occasional agitation.
Clay 2000 ,, }

1st Analysis of the resulting Liquid—

Grains.		Platinum Salt.		Potash.		Per Cent.
168·36	gave	6·28	=	1·212	or	·7661

2nd Analysis—

150·42	gave	5·78	=	1·116	or	·7417

1st Analysis. . . .	·7661	per Cent.
2nd ,, ...	·7417	,,
Mean . . .	·7539	,,

100 grains of the original Solution contained .	1·0029	grains of Potash.	
100 grains of the resulting Liquid contained .	·7539	,,	,,
Loss by each 100 grains of Solution . .	·2490	,,	,,

The whole loss will consequently have been 9·960, which has been absorbed by 2000 grains of clay, making the absorption ·4980 per cent.

With a stronger solution of the nitrate we have here an increased absorption. A solution of free or caustic potash was now made to compare with the last—great care was taken that the solution should be free from carbonate, which might have deranged the results, and for this purpose the sticks of potash were dissolved in alcohol, which was subsequently distilled off. After several trials a solution was obtained which afforded on analyses the following results:—

1st Analysis—

Grains.		Platinum Salt.		Potash.		Per Cent.
208·36	gave	10·71	=	2·067	or	·9922

2nd Analysis—

166·45	gave	8·73	=	1·685	or	1·0124

1st Analysis . . .	·9922	per Cent.
2nd ,, . . .	1·0124	,,
Mean . . .	1·0023	,,

The following experiment was made with the above solution:

Experiment 83.—Solution of Caustic Potash (of 1 per cent.) and white clay.

Solution 4000 grains } Digested in the cold with shaking for 12 hours.
Clay . 2000 ,, }

1st Analysis of the resulting Liquid—

Grains.		Platinum Salt.		Potash.		Per Cent.
119·30	gave	2·91	=	·5617	or	·4708

2nd Analysis—

190·66	gave	4·78	=	·9226	or	·4839

1st Analysis . . .	·4708	per Cent.
2nd ,, . . .	·4839	,,
Mean . . .	·4773	,,

100 grains of the original Liquid contained	1·0023	grains of Potash.	
100 grains of the resulting Liquid contained	·4773	,,	,,
Loss by each 100 grains of Solution . .	·5250	,,	,,

The whole quantity of liquid (4000 grains) will therefore have lost 21·00 grains, which has been absorbed by 2000 grains of clay, making the absorption by 100 grains of clay to be 1·050 grains.

With caustic potash we have then an absorption by the clay of double the amount that occurs with the nitrate of this base. Without stopping to account for this circumstance, for which indeed the data are insufficient, we pass on to other experiments of a similar kind.

Experiment 84.—White clay *boiled* with solution of Caustic Potash of 1 per cent.

Solution of Caustic Potash .	4000	grains.
White Clay	2000	,,

boiled together for half an hour, cooled by immersion of the flask in water, and the exact weight of the original liquid made up by the distilled water, so as to compensate for loss by evaporation.

1st Analysis of the resulting Liquid—

Grains.		Platinum Salt.		Potash.		Per Cent.
214·25	gave	4·62	=	·8918	or	·4162

2nd Analysis—

265·72	gave	5·74	=	1·1079	or	·4169

1st Analysis	·4162	per Cent.
2nd ,, ...	·4169	,,
Mean . . .	·4165	,,

100 grains of the original Solution contained	1·0023	grains of Potash.	
100 grains of the resulting Solution contained	·4165	,,	,,
Loss by each 100 grains of Solution . .	·5858	,,	,,

The whole quantity (4000 grains) will consequently have lost 23·432 grains, which has been absorbed by 2000 grains of clay, making the absorption 1·1716 per cent.

When simply digested with the solution of potash in the cold the clay absorbed 1·050 per cent. of potash. When the materials are boiled together the absorption is somewhat greater or (as above) 1·1716 per cent. This, however, is not a material difference. In analytical chemistry it is usual to employ caustic potash as a means of separating silica from other substances with

which it may be mixed. When boiled with potash the silica is dissolved and forms a soluble silicate of the alkali. In the experiment which has just been described we find clay, which is usually thought to contain silica in a free state, not only refusing to give up that silica to potash, but actually combining with and removing from solution the alkali. It should be understood, however, that this result is affected by the relative proportions of the two substances, since a stronger solution of potash will, even in the case of clay, dissolve out silica.

The experiment is of interest, however, in showing how powerful is the tendency of soils to form new compounds where the opportunity of gratifying that tendency may be offered them.

It will be remembered that in the account of the experiments with ammonia, clay that had been boiled with hydrochloric acid was found to absorb nearly as much ammonia as that which had not been so treated (see Experiment 79). The following is a result obtained by digesting the acid-treated clay with caustic potash.

Experiment 85.—White Pottery clay boiled in Hydrochloric acid, &c., (see page 354) and Caustic Potash of 1 per cent.

Acid-treated Clay . .	2000 grains	Boiled together, as in the last Experiment, for half an hour.
Solution of Caustic Potash	4000 ,,	

1st Analysis of the resulting Liquid—

Grains.		Platinum Salt.		Potash.		Per Cent.
200·95	gave	4·10	=	·7914	or	·3938

2nd Analysis—

233·30	gave	4·78	=	·9227	or	·3954

1st Analysis	·3938 per Cent.
2nd ,, ...	·3954 ,,
Mean	·3946 ,,

100 grains of the original Solution contained .	1·0023 grains of Potash.
100 grains of the resulting Solution contained	·3946 ,, ,
Loss by each 100 grains of Solution . .	·6077 ,, ,,

The whole quantity (4000 grains) would therefore have lost 24·308 grains of potash, which has been absorbed by 2000 grains of the clay, making the absorption 1·2154 per cent.

The absorption by the acid treated is therefore slightly more than by the natural clay, so slightly, however, as to justify us in believing the amount the same in both cases. This agrees with the result obtained in the corresponding experiment with ammonia, and sufficiently proves that the absorptive power is not due to any substances, such as free alumina, that are soluble in boiling mineral acids.

The experiment which follows exhibits a greater absorptive power for potash in a clay after being boiled with caustic potash:—

Experiment 86.—A yellow clay from Cornwall was boiled with hydrochloric acid for an hour, and subsequently digested with the acid at a high temperature for 24 hours. The acid being poured off, the clay was repeatedly washed with distilled water, and finally dried ; it was after this treatment quite white, oxide of iron and alumina having abundantly dissolved in the acid liquid.

Solution of Caustic Potash of 1 per Cent.	2000 grains	Digested in the cold for 2 hours.
Acid-treated Clay	500 ,,	

1st Analysis of the resulting Liquid—

Grains.		Platinum Salt.		Potash.		Per Cent.
160·96	gave	4·07	=	·7854	or	·4881

2nd Analysis—

166·07	gave	4·07	=	·7856	or	·4730

1st Analysis . . .	·4881 per Cent.
2nd ,, . . .	·4730 ,,
Mean . . .	·4805

100 grains of the original Solution contained	1·0023 grains of Potash.
100 grains of the resulting Solution contained	·4805 ,, ,,
Loss by each 100 grains of Solution .	·5218 ,, ,,

The whole quantity (2000 grains) would therefore have lost 10·436 grains, which has been absorbed by 500 grains of clay, making the absorption 2·087 per cent.

The last experiment exhibits a clay which, after being boiled in acid, absorbs twice as much potash as the one previously examined, and it may be assumed that, had the experiment been tried, this clay in its natural state would have been equally active. On the other hand, it has been shown (Experiment 80 *a*) that in the power to separate ammonia from its salts this clay in its natural condition is comparatively deficient; so that we have a further illustration of the fact that the absorption for free alkalis and for the salts of these bases is in many cases of very different intensity, and due, therefore, to an entirely distinct condition in the soils.

The preceding experiments are sufficient to give an outline of the *extent* of power possessed by the soil for the absorption of potash, and it would serve very little purpose to have extended them to other salts of this base, which obviously would be governed by the same general law.

Absorption of Lime.

It has been before stated that the salts of lime generally are not subject to alteration or detention when filtered through soils. These salts are indeed products of the decomposition by the soil of those compounds which are subject to its influence, muriate of ammonia or sulphate of potash yielding corresponding salts of lime when placed in contact with the soil. The only solutions of lime which come under the absorbing power of soils are those of free lime itself and of the bi-carbonate. The following ex-

periment was made with the view of ascertaining the extent of the power of clay to absorb free or caustic lime.

Experiment 87.—White clay and lime-water.—A saturated solution of lime in water was analyzed in the usual way, and found to contain 1·211 grains of lime in each 1000 grains, or ·1211 per cent.

White clay . . .	2000 grains	Digested together for 12 hours.
Lime water . . .	4000 ,,	

1000 grains of the resulting solution precipitated by oxalate of ammonia in the usual way gave ·10 grains carbonate of lime, equal to ·056 lime.

1000 grains of the original lime water contained . .	1·211 lime.
1000 grains of the resulting liquid	·056 ,,
Loss by each 1000 grains of liquid .	1·155 ,,

The whole 4000 grains will therefore have lost 4·620 grains of lime, which has been absorbed by 2000 grains of clay, or at the rate of ·2310 per cent.

Experiment 88.—White clay and bi-carbonate of lime.—Lime water of the previous strength was diluted with twice its weight of water, and well washed carbonic acid was passed through it till the carbonate of lime first produced was completely redissolved. This solution would contain one-third of the lime of the lime water itself, or ·404 grains in 1000.

Solution of bi-carbonate of lime .	4000 grains.	Digested together for 48 hours.
White clay	2000 ,,	

2000 grains of the liquid when analyzed gave ·084 of lime, or ·042 lime in 1000.

1000 grains of the original liquid contained . . .	·4040 lime.
1000 grains of the resulting liquid	·0420 ,,
Loss by each 1000 grains	·3620 ,,

The whole 4000 grains would consequently have lost 1·448 grains lime, which has been absorbed by 2000 grains of clay, or at the rate of ·0724 per cent.

On examining these two experiments, more especially the last, it became evident that they were unsatisfactory in their results, inasmuch as the solution of lime-water being necessarily dilute (in fact, containing only one-tenth of the quantity of alkali that the 1 per cent. potash solution did), scope was not given for the full absorption. That *all* the lime did not disappear from the liquid must be ascribed to a certain solubility of the compounds formed with it in the clay.

It became necessary to make experiments in which either the quantity of lime should be greatly increased, or that of the clay proportionably diminished; the latter alternative was chosen in the following trials:—

Experiment 89.—

Lime water of previous strength .	4000 grains.	Digested for 2 hours.
White clay	100 ,,	

1000 grains of the original lime water contained	1·211 lime.
1000 grains of the resulting solution	·844 ,,
Loss by each 1000 grains of solution . . .	·367 ,,

The whole quantity of lime-water would therefore have lost 1·468 grains lime; and since 100 grains of clay was employed in the experiment, the per-centage absorption is the same number, or 1·468 per cent.

Experiment 90.—2000 grains of the same lime-water, diluted with 6000 grains of distilled water, and well washed carbonic acid, passed through the solution as before. The object of diluting the solution was to prevent separation of the crystalline bi-carbonate, which occurs when the lime water is too strong.

The above solution of bi-carbonate .	8000 grains.	Digested together for 2 hours.
White clay	100 ,,	

The lime in the whole quantity of the original solution was .	2·422 grains.
In the whole quantity of the resulting solution	1·691 ,,
The difference being	·731 ,,

—which is the absorption by 100 grains of clay.

Experiment 91.—Lime-water and clay.—In this experiment a solution of lime containing 1·052 of lime in every 1000 grains was employed.

Lime water . . .	3500 grains.	Digested together for 24 hours.
White clay . . .	100 ,,	

The whole quantity of the original solution contained .	3·684 grains.
The whole quantity of the resulting solution	2·567 ,,
The difference being	1·117 ,,

—which is consequently the absorption by 100 grains of clay.

In the three last experiments a great increase of the absorptive power is observed, the quantity of lime absorbed by 100 grains of clay being something very considerable.

That the absorption of the bi-carbonate of lime by the clay is due to an action entirely different from that which causes the detention of lime itself, has before been remarked. The soluble bi-carbonate of lime is an acid salt, and it is obvious that to arrest and combine with it the soil must offer to the excess of carbonic acid some saturating base. I have every reason to believe that clay (and soils generally, in virtue of clay) contains lime in a form which is available for the neutralization of the bi-carbonate of lime, which is thus converted into the ordinary insoluble carbonate; and there is much ground for hope that the theory of liming, as a means of renovating and improving the soil, will receive much explanation from the further investigation of this most interesting branch of the subject.

Absorption of Magnesia and Soda.—No very definite experiments on the *extent* of the power of soils to arrest these bases have as yet been made.

Absorption of Organic Matters.—Hitherto we have confined our attention to the mineral ingredients of manure, but the absorptive power of soils extends also to the detention of organic matters. In the early part of this paper it was stated that Mr. Huxtable had observed and related to the author the

singular fact that putrid urine, when filtered through a soil, was deprived of colour and smell, and reduced in external characters to the condition of ordinary water. The destruction of colour and smell would, of course, imply either an alteration or a total abstraction from the urine of those substances to which these qualities are due. Now, since all putrid smells are more or less connected with the presence of nitrogenic matter in a state of change, it would become a matter of great importance to decide to which of the above causes the purification was due. If by filtration through a soil the animal matters of urine were merely altered—transformed, for instance, into nitric acid—they need not necessarily (and, in the case of nitric acid just stated, decidedly would not) be retained by the soil. But numberless observations in practical agriculture would, when rightly interpreted, lead us to believe that fertile soils *have* the power of arresting matters containing nitrogen, and retaining them in such a form that in due time they become available as food for plants. I am unable to give more than a general sketch of the property of soils to combine with the organic portion of manure, but the experiments that have now to be described, though inadequate to explain the *cause*, sufficiently establish the *fact*, and they must be received as an earnest of the rich reward awaiting the further prosecution of this most interesting research.

Experiments in Filtering Putrid Urine.

Experiment 92.—Two filtering tubes, each 24 inches long, were filled to the depth of 18 inches with Mr. Huxtable's light soil. Upon these filter-beds a quantity of highly offensive stinking tank water was poured. Owing, however, to the fineness of the soil, and to a sedimentary deposit from the liquid at the surface of the soil, the filtration was very slow, and at the end of 36 hours none of the liquid had passed. The soil was then pushed out of the tubes. The liquid had so far penetrated the filter that the portions near the bottom were quite wet, but they exhibited no smell, and it was not till 12 inches of the wet soil had been ejected that any, even the smallest, smell of the urine was perceptible.

Experiment 93.—The same soil was mixed with its own weight of white sand to make it more permeable; in other respects the experiment being made in the same way as the last. The liquid did not pass for several hours, but ultimately more than 1 ounce of it passed, *quite clear*, free from smell or *taste*, except a peculiar *earthy* smell and taste derived from the soil. It contained no ammonia, as would be expected from experiments already described, but salts of lime in considerable quantity.

These experiments sufficiently corroborate Mr. Huxtable's observation of the action of a soil upon the colouring matters and substances producing smell of putrid urine. They have been repeated with many different soils and under every possible combination of circumstances, but still with the same effect. It would be tedious and useless to relate all these experiments in detail, and it may be sufficient to state that similar results were obtained by

acting upon putrid human urine, upon the stinking water in which flax had been steeped, and upon the water of a London sewer. That the power of the soil in all these cases is due to the *clay* contained in it there is not the slightest doubt; many similar trials were made with sand, but although the colour, so far as it was due to suspended matter, was in some degree reduced, the offensive character of the solutions was but slightly modified. On the other hand, the pure white clay, so often before mentioned, proved an admirable absorbent both of colour and smell. It is worthy of remark, that by merely stirring up a portion of soil or of pure clay with the solution, the same result is obtained, though not in the first instance so perfectly. If, however, the liquid, in great measure deprived of colour and taste, is poured off, and treated with a second quantity of the absorbing soil, the effect is equally complete as when a process of filtration has been adopted.

Solutions of different colouring matters, such as those of logwood, sandal-wood, cochineal, litmus, &c., when filtered through or shaken up with a portion of clay, are entirely deprived of colour. Alumina is known to possess an extraordinary power to combine with colouring matters, and is extensively used in dye-works as a *mordant*. It would, therefore, naturally be supposed that the decolorizing power of clay was due to the free alumina; but granting even that free alumina exists in clay, of which there is no sufficient proof, it is certain that other compounds of alumina exist in the clay possessing this power. Thus, white clay, when boiled with hydrochloric acid (which dissolves out the alumina), and subsequently well washed, retains apparently in undiminished force the power both of precipitating the colouring matters of logwood, &c., and also of decolorizing and deodorizing putrid urine and other offensive animal solutions; and we must therefore believe that there are compounds of alumina with silica, having in some respects the same chemical properties as alumina itself. In what form of combination these colouring matters and the organic substances giving smell are retained by the clay it is very difficult to say. All organic matters are certainly not abstracted from solution to the same extent. Thus a colourless solution of sugar will pass apparently unaltered through a filter of clay and sand, whereas if it be coloured the clay will act like animal charcoal, completely removing the colouring matter. It concerns us very much to know for what substances and to what extent this power of soils to unite with organic matters is operative. So far as the experiments have at present been carried, it would appear that there is a greater power in the soil for retaining the *products of the decay* of animal matters than the animal matters themselves.

Fresh urine is purified—that is to say, deprived of animal

matters and salts—by filtration through clay; but the action appears to be much more limited than when the urine is used in a state of putridity. Still there is good reason to hope that in the case of fresh urine the power of good soils is practically sufficient. Many experiments have been made with a view of gaining a general notion of the extent of the power in question; in one instance 500 grains of clay mixed with half a pint (3500 grains) of fresh urine deprived it of colour, and carried down all the animal matter.

Clay appears to have a remarkable action in reference to the fermentation of organic matters. It seems indeed to oppose fermentation, as will be seen in the following experiment:—

Experiment 94.—Three quantities of fresh urine, of 2000 grains each, were measured out into similar glasses. With one portion, its own weight of white *sand* was mixed: with another, its own weight of white *clay:* the third being left without admixture of any kind.

When smelt immediately after mixture, the sand appeared to have had no effect, whilst the clay mixture had entirely lost the smell of urine: they were all decidedly acid to test paper. The three glasses were covered lightly with paper and placed in a warm place, being examined from time to time. In a few hours it was found that the urine containing sand had become slightly putrid; then followed the natural urine; but the quantity with which clay had been mixed *did not become putrid at all*, and at the end of 7 or 8 weeks it had only the peculiar smell of fresh urine, without the smallest putridity. The surface of the clay, however, became afterwards covered with a luxuriant growth of confervæ, which did not happen in either of the other glasses.

This is a remarkable experiment, and one from which eventually much instruction may be derived. The reason that the sand accelerates the fermentation of the urine is no doubt this: all bodies possess a surface attraction for gases, and of course therefore for common air. This attraction, which enables them to condense a certain quantity of air on their surfaces, is in direct relation to the extent of those surfaces. In mixing sand with the urine, we are in effect exposing the latter to a largely increased surface of air, the oxygen of which is necessary to commence the putrefaction—and thus hastening the changes which soon or late would occur in the urine naturally. But what shall we say of the action of the clay? that it retards or changes the nature of the putrefaction is evident; but the question is, does it prevent the conversion of the animal matters into the ordinary products of decay; or does it allow of that conversion and absorb those products as they are formed? This is a most vital question to practical agriculture, clearly affecting our views of the state in which animal manures should be employed, and affecting also in the highest degree the theoretical notions of vegetable nutrition. Should it be proved that the clay in soils possesses the power of altogether arresting putrefaction, and that urea and other animal matters remain unchanged in the soil, we shall be driven to allow

that plants have actually the power of feeding on these primary compounds—a view which it is almost needless to say has been all but abandoned by chemists and vegetable physiologists of the present day.

An experiment now to be described is rather in favour of the belief that clay actually *prevents* the putrefactive process.

Experiment 95.—Fresh human urine was filtered through white clay, mixed with its own weight of sand. The first portion came through colourless; by and by, however, the urine itself passed through apparently unchanged. Several ounces were collected, and by accident remained on the table beside a quantity of the same urine which had not been so filtered. At the end of several days it was observed that the filtered urine was quite sweet, whilst the other had passed into a state of putridity; and for more than a month, during which it was kept, this filtered quantity remained in the state, having the smell of fresh urine without the smallest putridity: the clay in fact had destroyed its power of fermentation.

It is believed that the spontaneous putrefaction of urine is due to the presence of portions of mucus from the bladder, and the idea will suggest itself that filtration by removing this mucus destroys the susceptibility to spontaneous change; but I have found that filtration through the finest paper does not prevent urine from fermenting; and further, that by merely stirring up clay with urine—the latter being greatly in excess—allowing the liquid to clear itself, and pouring it off, further change is altogether prevented. It is quite likely that the clay combines with the organic bodies acting as ferments, and thus removes them from the solution; but however it may be explained, of the fact there can be no dispute.

The result in the first experiment, where urine and clay were digested together, is susceptible, as before said, of two explanations —1st. That no putrefaction takes place; or, 2nd. That the products of putrefaction are absorbed, and consequently do not become evident to the senses. We have seen that clay destroys the smell of putrid urine; consequently, so fast as it became putrid the evidence of putrefaction by smell would be destroyed. In this way we may suppose the whole of the urea and other animal matters to pass into secondary and even final or ultimate products of decomposition without the smallest external sign that such change had occurred. But this conclusion is irreconcilable with the fact that clay, when used in small quantity, although it removes only a part of the animal matters of urine, destroys the tendency to spontaneous putrefaction in that which is left. The inference from these united observations would be, that urine and other animal liquids, when mixed with the soil, do not undergo the ordinary decomposition.

No decided opinion, however, should be formed on so important a subject upon imperfect data; and for the present we must be content to believe simply that the phenomena of fermentation and

putrefaction are very much modified when the soil comes into play. An experiment of the same nature as those before mentioned was made with human fœces, which were covered in two glasses—the one portion with sand and the other with white clay, each to the depth of about 2 inches. The materials were loosely placed in the glasses, and not incorporated together, so that the air had access to the excrement, although imperfectly. The smell from the glass containing sand, particularly after some little time, was very bad, but from the fœces and clay no other than a slightly acid but not putrid smell was for weeks evident.

Having now brought forward ample proofs of the existence, in reference to the organic and inorganic substances of manure, of a power in soils, which has hitherto hardly been suspected, I shall endeavour to give a practical idea of the extent of the property when it acts upon the mixed constituents of a manure, by describing two experiments which have been made with that view. The first of these shows the action of white clay upon flax-water—the putrid liquid which results from the steeping of the flax plant; the second experiment exhibits the action of a soil upon the water of a London sewer.

Experiment with Flax-water and Clay.—The following is the analysis of the flax-water used in this experiment:—

An imperial gallon contained—

	Grains.
Organic matter	180·80
Phosphoric acid	8·76
Sulphuric acid	18·08
Carbonic acid	21·53
Lime	33·06
Magnesia	8·54
Peroxide of iron	17·44
Potash	48·84
Soda	none
Chloride of sodium	42·21
Chloride of potassium	60·83
Silica	4·93
Total solid matter in a gallon	445·02

The organic above contained 3·28 grains (in a gallon) of nitrogen, none of which appeared to be in the form of ammonia.

Experiment 96.—With 48 ounces of this flax-water 16 ounces of white clay were mixed in a wide-mouth bottle, the materials being well agitated together. The fetid smell of the liquid was greatly diminished, but not entirely removed. After the addition of 8 ounces more of the clay, the offensive odour of the flax-water was entirely removed, but the liquid still retained a peculiar odour, which seems to be due to some acid substance formed in the fermentation of the flax.

The clay was now allowed to fall to the bottom, and the clear and colourless fluid was decanted off, and evaporated carefully to dryness. The residue still contained organic matter of some sort, but it was *entirely free from nitrogen.* Neither did it contain phosphoric acid, potash, or magnesia. The following analysis exhibits the composition of the mineral residue of an imperial gallon of this liquid:—

	Grains.
Oxide of iron	5·20
Lime	32·18
Carbonic acid	not ascertained
Sulphuric acid	20·34
Chloride of sodium	86·78

It will be observed that the quantity of lime and sulphuric acid in the resulting are, within errors of experiment, the same as in the original liquid; the quantity of chlorine is also as nearly as possible the same in both liquids; but in the original flax-water part of it was in combination with potassium, which, after treatment with clay, has been replaced by sodium. We have here two results which were unexpected: the first, that the quantity of lime should not be increased, which seems opposed to the principle before laid down, that lime replaces in the liquid the potash and magnesia previously combined with sulphuric and muriatic acids; the second peculiarity is the existence in the resulting solution of much more soda than existed in the flax-water itself. This soda can only have been derived from the clay, which we find from the analysis (page 320) contains the alkali in considerable quantity. It would seem therefore, that in the present instance soda, and not lime, has acted the part of the substituting base. It is useless, at this stage of the investigation, to attempt to reconcile these apparent inconsistencies, and we shall pass on to describe an experiment made upon the filtration of the water of a London sewer through a bed of soil.

The sewer-water employed had the following composition:—

Analysis of Sewer-water.

	An Imperial Gallon contains (in grains and tenths)—		
	Soluble.	Insoluble.	Both.
Organic Matter and Salts of Ammonia	121·50	180·32	301·82
Sand and Detritus of the Granite from the Streets	*1·39	19·30	20·69
Soluble Silica	1·57	10·94	12·51
Phosphoric Acid	7·71	2·73	10·44
Sulphuric Acid	10·71	4·02	14·73
Carbonic Acid	11·62	3·97	15·59
Lime	7·50	17·03	24·53
Magnesia	2·87	Traces.	2·87
Peroxide of Iron and Alumina	Traces.	6·20	6·20
Potash	46·91	1·22	48·13
Soda	None.	1·51	1·51
Chloride of Potassium	None.	None.	None.
Chloride of Sodium	31·52	1·72	33·24
	243·30	248·96	492·26

* This is some small proportion of insoluble matter escaping the linen filter, and properly belonging to the other column.

It also contained nitrogen, the greater part of which existed in the form of ammonia, whilst a small portion was present in the solid animal and vegetable matters of the sewer water.

Ammonia, in a gallon, 41·28 grains, of which 36·72 actually *existed* as ammonia.

The filter through which this sewer-water was passed consisted of 4 lbs. of Mr. Pusey's soil placed in a glass cylinder, which it filled to the depth of 6 inches. The liquid began to pass through in about ten minutes, and in two hours about half a gallon (5 lbs.) was collected. The filtration had deprived it of colour and smell. The insoluble matter of the sewer-water was, of course, arrested mechanically, being in great part found as a black slime on the top of the soil. Upon analysis, a gallon of the filtered liquid was found to contain 248·50 grains of solid matter, consisting of—

	Grains.
Organic matter, *destitute of nitrogen*	60·58
Chloride of sodium	52·73
Chloride of magnesium	·67
Chloride of calcium	8·89
Carbonate of lime	104·98
Sulphate of lime	17·49
Loss on the analysis	3·16
	248·50

The filtered liquid contained no potash, no ammonia or nitrogen in any form, no phosphoric acid, and a much reduced quantity of magnesia. There is an excess of chloride of sodium in the filtered liquid, which can have only been derived from the soil, although the analysis (given at page 319) failed to denote its presence. This will not surprise us when we remember that the 20 grains of common salt has been obtained from 10 lbs. (or 70,000 grains) of soil, so that 100 grains of soil would contain only about $\frac{3}{100}$ths of a grain of common salt, which might easily escape notice.* It will be observed that the total solid contents of a gallon of the sewer-water is *greater* after filtration than before —a circumstance which is due to the presence of a large quantity of carbonate of lime, which seems to have been dissolved by the free carbonic acid generated in the sewer-water by the gradual decomposition of its organic contents. We find in the present case that the soluble organic matter is reduced by one half; that which remains has a peculiar smell resembling honey, and burns with a bright flame as wax or grease would, but what its exact composition is has not been ascertained, further than that, as before mentioned, it contains no nitrogen.

This experiment, on the whole, is most gratifying. Independently of the matters which are mechanically arrested, we find that the soil retains the greater part—in most cases the

* The method of filtration, operating upon a large quantity of soil through which distilled water should be passed, might very usefully be practised in the analysis of soils, for the determination of those ingredients which are soluble in water, where they exist in very small quantity.

whole—of those ingredients of manure upon which we are accustomed to place the most value. And to what extent does this action take place? The absorption extends to a weight of sewage-water *more than equal to the weight of the soil,* and how much further it might have gone we know not, because the experiment was not carried beyond. If in practice every portion of the soil of an acre of land could have been brought into activity as a filter for this sewer-water, and that the soil so saturated had been but 10 inches deep, 1000 tons or 224,000 gallons of undiluted sewage-water might be thrown upon it, and the water would have passed away by the drains deprived of its principal manuring properties.

Now 1000 tons or 224,000 gallons of this sewer-water would contain, according to the analysis, about half a ton of real ammonia, and other things in proportion. In other words, to put on a quantity of this sewage equal to the weight of the soil to the depth of 10 inches would be to manure an acre of land with 3 tons of Peruvian guano, which is fully 20 times the quantity that would actually be employed.

I would carefully guard my readers from supposing that this argument is meant to apply literally to practice. It is of course impossible to render the soil of a field so equally permeable as that used in the small experiment just described, but with the caution that such is the result under the *most favourable conditions,* it can do no harm, but much good, to bring forward a calculation which shows that a good and well comminuted soil, sufficiently porous to allow of the gentle descent of liquids, and yet not so open or fissured as that they should find their way by what may be called *perpendicular drains* into the ordinary drains below, and above all, containing a fair amount of the absorbing ingredient, the clay,—that such a soil will receive and retain many times the quantity of manure that is likely to be put upon it in the ordinary course of management, without the smallest need for fear on the part of the farmer that it shall be lost in the drains, provided that the preservative powers of the soil be properly understood and brought into play.

I shall forbear in the present paper from giving any very precise opinion as to the cause of the absorbent power which we have been studying. Those who have taken the trouble to read the account of the experiments will have seen that they dispose of some of the forms of explanation which might have been suggested, and at the same time reduce the question to a much narrower compass; but it would be premature to offer an opinion which it is hoped will be much more worthy of consideration when the inquiry shall have been further prosecuted. It is right, however, to mention here that silica, in the state in which it may

be supposed to exist in clay (that is, soluble in acids and alkalies), has a power of combining with ammonia and other bases in a way not hitherto understood. Silica is really soluble in ammonia, although to a small extent only; when placed in a solution of ammonia it absorbs it, forming a silicate of ammonia, a part of which only dissolves in the liquid. It does not seem at all consistent with the facts to believe that the free silica of clay is the agent in these absorptions, but the observation that silica is soluble in ammonia, and that when the solution is gently evaporated the ammonia escapes and leaves the silica in thin films like a varnish, which break off from the containing vessel as a glass of wonderful lightness and transparency, may one day help to explain both the manner in which the cereals obtain their beautiful silicious coating, and the singular loss of nitrogen which Mr. Lawes has shown takes place in the growth of a crop of wheat.

Practical Conclusions.

It has been shown in the course of this paper that ordinary soils possess the power of separating from solution, and of retaining for the purposes of vegetation, the bases of the different alkaline salts and certain animal and vegetable substances, and that this power extends to all those substances to which we attach the chief value as manure. Until we are in possession of a full knowledge of the *cause* of this peculiar action, and the circumstances under which it becomes operative, we should not be justified in insisting upon any general application of the principles in question to practical agriculture.

Still, however, there are certain logical deductions which seem to follow as a matter of necessity from a consideration of the facts, quite independent of the laws upon which they depend. And first in regard to manures:—

We mix sulphate of ammonia with a soil either in the solid state or as a solution. Sulphate of ammonia is a very soluble salt, and when subsequently we add water in quantity to the soil, it may naturally be expected to bring away with it some sulphate of ammonia, but it does not, neither is ammonia in any shape dissolved out. Now whatever may be the form of combination in which the ammonia is retained by the soil, it is plainly in an *insoluble state.* Further, the sulphuric acid is now found combined with lime, and the sulphate of lime is, as usual, in the soluble condition. If, instead of sulphate of ammonia, we have used the muriate of the same base, we find in the liquid muriate of lime, the ammonia being retained as before. Obviously in both instances the particular salts of ammonia cease to exist as such directly they are mixed with the soil. Instead of the sul-

phate or muriate of ammonia, we have a new and at present unknown compound of that base. What is the first natural and undeniable inference? That as a source of supply of ammonia to the soil it is indifferent what salt we employ—neither the sulphate nor the muriate is direct food for plants, but they are with equal ease converted into compounds which can furnish that food. This is an important and beautiful truth, and is well worth all the labour expended on the investigation.

Mr. Solly made experiments some years ago at the Chiswick Gardens upon the comparative action of different salts of ammonia on wheat, and could find no difference in their effects. Mr. Lawes and Dr. Gilbert, in their admirable experiments at Rothamsted, have observed that it made no difference what salt of ammonia or potash was employed. At first they used the carbonates, as appearing the most natural form in which to present them, but they now employ the *cheapest* salts of these bases. The explanation of these interesting observations is now forthcoming, and it may be taken as a principle that in artificial manuring, where any particular alkali is to be employed, the choice should fall on the salt which affords the cheapest supply of that alkali. Of course this principle must be applied with judgment, and it is obviously inapplicable where the acid of the salt is of great agricultural value. Thus the carbonates, sulphates, and muriates, must be put in a different class from the phosphates and nitrates. Further, the insolubility of the alkaline compounds formed in the soil has a close bearing upon the method of applying artificial, and in fact all kinds of manure. It has been shown that a moderately fertile soil will unite with 3-10ths per cent. of ammonia; in other words 1000 lbs., or 1000 tons, will combine with 3 lbs., or 3 tons, of ammonia.

An acre of soil one inch in depth, weighs about 100 tons—10 inches deep, therefore, 1000 tons. Now an acre of soil worked to the depth of 10 inches, would upon this showing take up 3 tons of ammonia, a quantity which is supplied in 15 tons of sulphate of ammonia. A large dressing of this salt would be 5 cwt. to the acre, consequently we have 60 times the power in the soil that is actually needed. Now comes the inference: when a salt of ammonia is applied to the soil it soon becomes combined with it, and remains fixed and insoluble. When once this combination takes place, there would appear to be no power in water further to distribute the manure. It follows, that if in the application of manure we are not careful to ensure an equal distribution, we entail upon the roots of the plants the necessity of seeking their food at a distance, and thus call for a greater expenditure of vital force.

Mr. Lawes tells me, that although he has taken great pains

to use the very best drills in the application of artificial manures in his experimental field, he is constantly reminded of his only partial success by the irregularity of the crop. It is obvious that if these artificial soluble salts remained as such in the soil, then distribution by rain and capillary attraction could not fail of ultimately taking place. And this brings me to notice that capillary action, which has been supposed to play an important part in the changes of the soil, can have little influence except on those salts which are really in a state of solubility in the soils; namely, the salts of lime.

The methods by which an equal distribution of manure is to be effected, must be left with the farmer and the agricultural machinist; but I may observe, that much of the wonderful luxuriance following the employment of liquid manure, may fairly be set down to the very perfect way in which the new combinations in the soil are thereby produced.

The absence of power in the soil to unite with gypsum, or in any way to retain sulphuric acid, coupled with the certainty that sulphur is of absolute necessity to vegetation, may perhaps in part explain the advantage of applying sulphate of lime in certain cases. A soil well drained, containing naturally little gypsum, and situated in a district where the rainfall is considerable, may be supposed to stand in need of occasional assistance in this way. At the same time it seems as if nature had impressed upon gypsum a comparative insolubility in some measure to compensate for the impossibility of its being retained in the soil by the specific action which occurs in regard to other compounds.

The newly discovered property of soils explains and confirms the variations in manuring operations which are made to suit the nature of the soil. Clay has been shown to be the active substance in retaining manure, and sandy and gravelly soils not possessing a sufficiency of clay will be expected to be less retentive of manure. Such is the fact, and soils of this description are said not to "*hold manure.*" On such soils manure must be applied more frequently and in smaller quantities than in stiffer soils, where, owing to the retentive power of the clay, the manure for several crops may be safely deposited.

If these inferences be correct, the only way of permanently improving a sandy soil is to clay it, and it is notorious that the light sands of some parts of Norfolk are only made to bear crops by copious dressings of clay. It may be observed in passing, that where a dressing of clay is required it very often happens that the substance at hand is a marl, of which more than half is carbonate of lime, which (that is, the carbonate of lime) cannot be supposed to be a substitute for clay, inasmuch as, although it is capable of improving the mechanical texture of a sand or a gravel,

it has none of the chemical properties of combining with manure which clay possesses. In Norfolk this is frequently the case, and it would often pay the farmer to go a longer distance for real clay rather than apply that of inferior quality which lies under the surface.

Another and very important inference may be drawn from the facts now described. If nature has established a condition of the soil by which all the salts and manure pass into one uniform state in which they are presented to the plant—and if, further, it can be proved that the soils naturally most fertile and most fitted for successful cultivation are precisely those which, consistently with a proper mechanical texture, contain abundance of clay, such as free clay loams, then it would seem to follow that in an absolute sand or gravel manure applied in any quantity would not undergo the necessary changes and combinations, and that no vegetation in such soils should be perfectly healthy. In all good soils plants have one form only of potash, ammonia, magnesia, &c. presented to them. Is it likely that they can thrive equally well when, as in pure sand, these bases are offered to them in every possible form of combination? Reference has already been made to the possibility that clay possesses a power of retarding or altogether arresting the putrefactive process. Our information on this head is at present very limited; but should further inquiries prove that such is actually the case, it will be necessary very seriously to consider the state in which manure should be applied. It seems clear that manures in a fresh state are available to vegetation. What otherwise would become of the urine of sheep folded on turnips, and to which the success of the following barley-crop is justly attributed? That this urine and dung of the sheep, which is incorporated in a state of perfect freshness with the soil, does act upon the succeeding crop there can be no doubt, and if it should be proved that decomposition of animal matters does not go on in the soil, there will be no alternative but to believe in the power of plants to feed upon these matters in their fresh state. The property of the soil to arrest putrefaction and to combine with organic effluvia is matter of common observation; the practice of leaving a knife in the ground to remove the smell of onions, which nothing else will do so well, is one instance of this property.

The dog buries the bone which he cannot consume at one time in the soil, and returns for it at leisure. The fox in his wholesale depredations is known to secrete his booty in the earth, laying up stores in various places for his future use. In the same way venison is placed in the ground to keep it sweet, whilst it mellows. Every one has remarked that a country churchyard, where the bodies are not over-crowded, and the soil is sufficient for the

absorption of the products of decay, betrays to the senses no indication of the changes going on beneath the surface.*

But, it may be asked, why in such case does decay proceed at all if the soil has a tendency to arrest it? The answer is simply this—a large mass of animal matter, such as the body of a dog, buried in the earth is only very imperfectly brought into contact with the soil, and, consequently, decomposition takes place with an absorption of the products by the surrounding earth. The true influence of the soil in arresting putrefaction must be looked for in the case of liquid animal products, where perfect contact of the two is attained, and I have shown reason for the belief that in such cases this effect does really occur.

The advantage of efficient drainage of land receives an interesting confirmation from the facts now brought forward. To the soil is intrusted the preservation of manure, but in order that this preservative power may be exercised, the manure which is dissolved by rain in the superficial strata, where it is in excess or imperfectly distributed, must be brought by drainage into contact with active soil below by which it will be taken up. If, on the other hand, the land be undrained, this manure is carried off the surface into the watercourses.

Without venturing an opinion as to the depth of drainage, which must depend upon many circumstances, it may be fair to say that it should be such as to ensure the absorption of the manures by the soil; and in poor soils containing little clay, and, therefore, deficient in the power of arresting manure, it would seem that the draining off of water should not be the only object, but that we should seek to make up in *depth* of soil what is wanting in activity.

The fertilizing effect of burnt clay may seem to be at variance with the experiments which have been brought forward, showing that the more perfectly we burn clay the more certainly and effectually do we destroy its power of arresting manure. Let it be remembered, however, that the practice of burning soils is confined principally to heavy land which requires opening, that only a part, and a small part, of the whole is burned, and that, although the absorbent power—say, for example, of one-sixth of the soil—is destroyed, that of the other five-sixths is brought into more vigorous action, and the result is a positive good. It must not then be supposed that these experiments are against the

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* I am informed by Mr. Cunnington, of Devizes, who is known for his love of natural history, that the North American Indians, having taken a "skunk," or species of polecat, which stinks intolerably, in order to sweeten and render it fit for food bury the carcase, previously skinned, in the soil, where it speedily loses its offensiveness.

practice of burning, or of using burnt clay as manure*—a practice which must stand or fall upon its own merits.

The perfect comminution and disintegration of the soil, however effected, must render it more fertile, and place it in a position to benefit by the manuring influences of the atmosphere and rain, which are probably much greater than we at all conceive. Had Jethro Tull been aware of the property which we have been engaged in considering, he would in his intelligence have placed it foremost in the rank of those arguments by which his system of cultivation was maintained. That he had a *conviction* of the existence of some such power in the soil, and of a manuring power in the air, there can be no doubt; and since we have seen that a worked soil, although it contains perhaps only half its weight of clay, is yet more active as an absorbent than pure clay itself, we have further reason to believe in the wonderfully beneficial effect which Tull attributed to abundant stirring and trituration of the

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* The action of burnt soil rests, I believe, on some distinct principle not hitherto understood. Its effect upon the Oxford clay has been twice brought by me before the Society in this Journal, vol. vi., p. 478, and more recently, vol. ix. p. 422. It is quite evident that the action is not a merely mechanical one of opening the soil, but decidedly chemical. The last instance is conclusive on that point: for while four good crops of corn were thereby grown in succession on a cold clay, the ashes were not even mixed with the soil, being merely turned over with the breast-plough. The burning of clay does not answer on all clay soils, but it does answer on most of them, especially on the Oxford clay, which crosses England in a wide band; it answers also in Essex, Cambridgeshire, Bedfordshire (vol. iii. p. 323), and in Worcestershire. Mr. Randall's account of the process in vol. v., p. 113, should especially be consulted by the owners and occupiers of heavy land at the present time. But to return to the theory of burning soil. Mr. Bravender, in the present number, p. 160, states the good effect of the practice of stifle-burning. The most remarkable proof, however, is the circumstance that on peaty soils, and on stonebrash soil also, where each heap has been burned, though the ashes have been carefully removed, the utmost luxuriance of vegetation follows on the particular spot, and in contrast sometimes with utter sterility. I cannot but think that the effect may be due to the disintegration and decomposition of the soil bringing some of its chemical constituents from a dormant into an active state, and I should think it would well reward a chemist to examine into the whole question of the Torrefaction of Soils.—Ph. Pusey.

soil, by which continual exposure to atmospheric influences its absorbent power is greatly augmented.

In the use of *liquid manure* we may derive some important lessons from the study of the absorptive power of soils. It has been usual to apply manure in the liquid form wholly or principally to grass land, or to the artificial grasses, clover and Italian rye-grass. Without doubt there are practical difficulties in the use of this kind of manure to arable lands, but we may fairly assume that to some extent the limitation of its use is to be ascribed to the general impression that liquid manure must be applied to *the plants*. But we now find that by virtue of its absorptive power for the ingredients of manure we may leave to the *soil* the care of preserving these substances until they are wanted for a following crop. If we closely analyze our ideas of manuring, we shall find that they proceed upon the conviction that the earth is a great *strainer*, but not a *chemical filter;* and to throw liquid manure in large quantity on land not bearing a crop would be thought only a laborious means of getting rid of it by the drains. It follows, however, from the facts now developed, that if the practical difficulties are overcome, manure in the liquid form may be applied to *a fallow* without fear of loss.

This view may materially facilitate the employment of the liquid sewage of towns by rendering the application more constant, and thereby equalizing the demand for the manure.

The theory and practice of *Irrigation* will probably gain much assistance from a proper consideration of the absorptive powers of soils. The beneficial action of water on meadows has been the subject of much discussion: on the one hand * it has been attributed to the warmth of the water and the protection it affords to the herbage in the winter season; on the other, to the salts and organic matters thus supplied to the plants. The truth, as in most cases, may perhaps lie between these views, but so far as the beneficial effects of the water in a chemical sense are con-

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* There can be no doubt that the effect of irrigation in winter is a complex one, due to no single principle, but combining several. Warmth is one principle; the deposit of sedimentary matter is another. The filtration of soluble salts *may* be a third; but it must not be forgotten that by far the greater part of the water flows *over*, not *through* the land. Consequently we should take care that the runnings of yards should be allowed just to cover the land, and that the flow should then be stopped, in order that they may sink into it. It is remarkable that Lord Hatherton's meadows are irrigated entirely from drains, the water of which has therefore already undergone this very process of filtration before it fertilises the land.—Ph. Pusey.

cerned there is no doubt that it is closely connected with the power of the soil to detain the substances in solution. The roots of the plants which are supposed to take up the mineral and other matters presented to them could only do so to a certain and limited extent, and the greater part of the water must pass from the irrigated meadow almost as fully impregnated with these substances as at first. But we now see that the influence of the water is felt long after it has drained from the land, and that it has left behind it in the soil a rich manuring of those elements which plants delight in. If upon further investigation this view should turn out to be correct, the choice of water for irrigation will, other things being equal, rest with that kind which contains salts, &c. most suitable for manure, and every attention will be paid by thorough draining to enable the soil to act as a perfect chemical filter, and to bring its absorptive powers into full play.

Lastly, I have little doubt that when further progress has been made in the inquiry which is now being carried on, and it shall have been ascertained fully to what ingredients in clay the absorptive power of soils is due, and the various chemical properties of this particular substance shall have been carefully studied, that the theory of liming and the circumstances under which it is or is not admissible will be made plain. If, further, the investigation should, as may be hoped, throw light upon the cause of natural fertility in some soils, and the very different agricultural value possessed by land in all outward respects of similar capabilities, a great step will have been made in the right direction.

CORRIGENDUM.

In the article on Water-meadows, vol. x. p. 470, it was stated on the authority of Mr. James Ley that the fall on a meadow of Lord Poltimore's was only $4\frac{1}{2}$ inches in 1980 feet. I observed that this fall "was so wonderfully low, that unless the measurement had been given me by the person who laid it out, I could not have believed it." It turns out that Mr. Ley was in error in his statement. I have since examined the field, and find that, though to the eye the meadow is perfectly flat, the fall, as taken by the level, is much more than Mr. Ley stated, as is also the case on Mr. Barber's field mentioned in the same page.

I may take this opportunity of stating that the new mode of managing water-meadows recommended by me in that article, namely, by repeated penning of sheep, continues to answer, maintaining the stock invariably in good order, and that the only inconvenience arising hitherto from it is the enormous extent of stock which it requires to be purchased, and the difficulty even then of keeping the grass down.—Ph. Pusey.

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PART II.

PRACTICE WITH SCIENCE.

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These experiments, it is true, are not easy; still they are in the power of every thinking husbandman. He who accomplishes but one, of however limited application, and takes care to report it faithfully, advances the science, and, consequently, the practice of agriculture, and acquires thereby a right to the gratitude of his fellows, and of those who come after. To make many such is beyond the power of most individuals, and cannot be expected. The first care of all societies formed for the improvement of our science should be to prepare the forms of such experiments, and to distribute the execution of these among their members.

Von Thaer. *Principles of Agriculture.*

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The Binder is desired to place all the Appendix matter, with Roman numeral folios, at the *end* of the Journal, excepting Titles and Contents, which are in all cases to be placed at the *beginning* of the Part or Volume.

XXII.—*On the Progress of Agricultural Knowledge during the last Eight Years.* By Ph. Pusey, M.P.

It is a custom of many societies that the president should yearly review the progress made by them in their chosen field of research, recording any new facts which have been established, and pointing out those matters which appear to deserve and seem likely to reward their members' attention. Such a survey was attempted by me in 1842, when our Society had counted but four years from its outset; and now in 1850, when our labours have lasted eight more years, the time seems again arrived for rendering some account of what we have done. If one were otherwise disposed to shrink from the task, the present state of English farmers would render it doubly incumbent. But the task is no easy one. Other scientific societies deal chiefly either with facts, as the existence of some hitherto unknown insect, or bird, or mineral, or even planet, or else with some supposed new law of nature, electrical or astronomical. Those facts are simple: those laws single. If the speculator fall into error, no harm ensues. But not so in agriculture. Our facts are not simple, nor our laws single. They vary with the climate, the soil, the seasons. What is true in Kent is not true in Sutherland. While, too, there is so much more exposure to error, the consequences of error are also more serious; for a reader will easily forgive a mistake as to the supposed site of some Roman temple, but may not so readily forget the expenditure of twenty pounds on a useless manure. Besides this variation in facts and in rules, another difficulty arises from the difference in the knowledge and skill of farmers. You need not recommend a turnip-cutter to a Norfolk farmer who has used it for years, and you will recommend it vainly to a Welsh farmer who has never seen the instrument or even perhaps had a turnip to slice. What is a truism here will be derided there as a crotchet. The experience however of our best farmers is the safest source of improvement, and cannot be passed over, though for such readers there may be nothing new in the statement. Lastly, at this particular time other feelings bias men's judgments: but however the cause of present distress may be viewed, the need for exertion to cope with it cannot be doubted; and agricultural improvement, which might hitherto be looked on as a hobby for a few country gentlemen, is now become the unavoidable business of landowners generally. These difficulties have been stated in order to obtain indulgence for the writer in his attempt to sum up the principal points of English agriculture. Such an account should clearly aim at containing what is true, not what is new, and avoid the blame of being fanciful rather than of being commonplace. I wish to embody in a short report

the evidence of others whose writings have formed this Journal, not to obtrude any fancied discoveries of my own.

In taking this review I shall reverse the order adopted in the former survey, and say first a few words on the scientific rather than begin with the practical part of farming. My reason for the change is this :—The proper relation of science to agriculture has frequently been mistaken. It has been supposed that science, especially chemistry, was to guide and direct practical farming by conclusions formed on chemical grounds beforehand, and this mistake has not been without its effects. It is worth while then to consider the true relation of chemistry towards agriculture. Common chemistry teaches the action of substances upon each other, as of an acid upon an alkali, mixed in a vessel together. Organic chemistry endeavours to show the action of substances upon each other within the vessels of an animated frame, whether plant or animal; but the chemist does not say, because a mineral acid decomposes an organic salt, " I advise a gouty patient who has chalk-stones on his fingers to drink oil of vitriol, and get rid of them." He knows that the powers of life are too complicated for him, and leaves diseases to be dealt with by the physician. The physician, a man who has studied the art of medicine, that is, the recorded experience of ages, knows *practically* that certain drugs have certain effects, and he administers them. But a few years since, when it was found that soluble flint is contained in wheat-straw, silicate of soda, a salt of flint, was advertised and sold for some time to farmers, that the straw of their crops might be thus strengthened, and the crops might not be laid any more—an evil experienced widely however this year. The chemist has aided the physician in a different way. The physician found the efficacy of a certain bark in fevers. The chemist has extracted from the woody fibre a white powder like sugar, which contains all its medical properties. So Baron Liebig has taught the farmer, who already *knew* that bones were good for turnips, how to treat those bones with sulphuric acid, and present the phosphorus to the young plant in a more digestible form. But eight years ago it was supposed that we must supply to plants in manure nearly all the mineral ingredients contained in their ashes. Thus Baron Liebig—(I mention an error of his, because his high reputation will not be injured thereby, and the warning may be useful to others)—that eminent philosopher, I say, prepared and sold under patent a manure containing the mineral ingredients of wheat so prepared as to be slowly soluble, and therefore to supply what the wheat wanted when it was wanted. Ammonia was omitted, because ammonia, it was thought, would be supplied by the air. The scientific manure was applied, but the wheat did not mend. The mineral theory then eagerly adopted was contained in the following

axiom of Liebig's :—"The crops in a field diminish or increase in exact proportion to the diminution or increase of the *mineral* substances conveyed to them in manure." This doctrine received a deathblow from Mr. Lawes's experiments at Rothamstead in the following manner :—Plants, it is well known, consist chiefly of vegetable matter formed of oxygen, hydrogen, nitrogen, and carbon; the first gas forming water with the second, air with the third, and with the fourth substance carbonic acid, a gas largely diffused in the atmosphere. These then are the *organic* elements of plants. But further, the ashes of plants contain various minerals, potash, soda, lime, &c., combined with phosphoric and sulphuric acids in various quantities, and it was with these last, the *mineral* materials, that we were taught to build up our crops. Those indeed who were indisposed to extreme theories saw that two chemical bodies singled themselves out from all others by efficacy, namely, Phosphorus and Ammonia: the former as super-phosphate, seemed alone sufficient for turnips, but was also applied singly to wheat; the salts of ammonia, an organic manure as acting by its nitrogen, were applied not only to corn, but to roots also. It is necessary thus to recall past uncertainty that we may do justice to Mr. Lawes and Dr. Gilbert. Their experiments appeared in this Journal ;* and the shortest extract only need be given here. Wheat was grown at Rothamstead on an arable field exhausted for the purpose, and the results were as follows :—

	Bushels of Wheat per Acre.
Unmanured	$16\frac{3}{4}$
700 lbs. superphosphate	$16\frac{3}{4}$
Eight lots with various phosphates. Average	$16\frac{5}{8}$
Ash of 14 tons of farm-yard dung . . .	16
14 tons of farm-yard dung	22

It is evident that on this exhausted land the heavy dose of superphosphate and the other mineral dressings did nothing at all. *They* might have been ill selected, but the mineral contents of the *dung* did nothing; and this should be carefully observed, for the mineral theory lingers still among us, and it has been stated quite recently, in a popular lecture, that the slight mineral contents of a cartload of dung are all that is wanted by wheat. The effect, however, was clearly in the organic contents of the dung. This working power might be either in the carbon (charcoal or woody matter) or the nitrogen† (ammonia) of the dung. Unfortunately Mr. Lawes did not use ammonia singly, but he used it in combination with the following minerals, which we have seen to be valueless when standing alone :—

* Lawes on Agricultural Chemistry, Journal, viii. 226, and viii. 494.

† Ammonia consists of nitrogen and hydrogen. The former constitutes its value. Where no precision of scientific language is necessary, it is sometimes more convenient to use the term nitrogen, and sometimes the term ammonia.

					Bush.
1.	Superphosphate	635 lbs.	Sulph. Ammonia . .	65 lbs.	$21\frac{1}{4}$
2.	Various salts .	619 ,,	Ditto	65 ,,	$21\frac{1}{4}$
3.	Ditto . . .	619 ,,	Rapecake (*nitrogenous*),	156 ,,	$22\frac{3}{4}$
4.	Ditto . . .	646 ,,	Sulph. Ammonia . .	80 ,,	$26\frac{1}{4}$

The ammonia at once raises the wheat crop from 16 bushels to 21, that is, to about the level of the dung; and as more ammonia is given, more wheat is grown reaching 26 bushels, and surpassing what the dung can produce. These figures are conclusive that the action was in the nitrogen (ammonia) of the dung, not in its charcoal; and upon these experiments rests the now established doctrine that nitrogen is what white crops require. And it may generally be assumed for practical purposes that if ammonia be supplied to wheat, it will find the mineral ingredients for itself, either in the soil or in past or present dressings; not that pure ammonia can be supplied, for pure ammonia is too dear—but all the manures practically applied by farmers to wheat hitherto are of a nitrogenous (*ammoniacal*) character, namely:—

Dung.	Rape-cake.	Guano.
Sheep-folding.	Shoddy.	Nitrate of soda.
Woollen rags.	Sprats, &c.	Seaweed.

Thus experience is borne out by science.

The Rothamstead experiments on turnips are far more complicated, but I will endeavour to make a fair selection. They were equally tried on exhausted land, and repeated on the same ground for three years, the turnips being drawn from the land. The produce per acre is as follows:—

Season.	No Manure.		Dung 12 tons.		Superphosphate of Lime.		Mixed Earthy and Alkaline Phosphates.	
	Tons.	cwt.	Tons.	cwt.	Tons.	cwt.	Tons.	cwt.
1843 . . .	4	3	9	9	12	3	11	17
1844 . . .	2	4	10	15	7	14	5	13
1845 . . .	0	13	17	0	12	13	12	12

Here we find a result very different from the former one. The simple phosphorus which did nothing for wheat nearly equals the dung for turnips. But the mineral theory equally fails. For while 20 tons of turnips contain 45 lbs. of phosphorus, they contain 173 lbs. of alkalies, potash, and soda—so much indeed that they were classed in the alkaline family as specially requiring to be manured with alkalies; yet not only is the average crop produced by alkaline salts (*column* 4) the worst of the three—but the application of potash *diminished* the size of the bulbs, and Mr. Lawes observed that "by the direct supply of alkalies no good effect has arisen in the season of application; that they are rarely if ever requisite; and if ever, should not be applied in their *alkaline* condition."

Superphosphate, however, is slightly inferior to dung, and the question again arises as under wheat, whether this slight supe-

riority of dung for turnips be due to its nitrogen or to its carbon. For wheat it was due to nitrogen (ammonia). For turnips, Mr. Lawes proves it to be due to carbon, the matter of wood. In the third year the unmanured portion was cross-dressed, as follows:—

	Average Weight of Roots.			
	No Cross-Dressing.	10 cwt. Rapecake.	3 cwt. Sulph. Ammonia.	10 cwt. Rapecake, 3 cwt. Sulph. Ammonia.
No manure (third season) . .	·11	·67	·07	·50

Both rape-cake and ammonia are nitrogenous, but rape-cake contains carbon besides. Ammonia single does harm; while rape-cake, as in other cases, has been beneficial. Not even rape-cake, indeed, in dry weather is a safe neighbour for turnips. But carbon appears to be the distinctive active principle of dung for turnips. Here again our practice is borne out for the south of England. The dung is applied to the previous crop of wheat, which gets, what it wants, the ammonia, and leaves behind what it does not want, the woody fibre of straw (*carbon*), for the turnip-crop, which receiving also bones or superphosphate, is satisfied. Bran drilled in with turnips, containing phosphorus, acts like bones, as does also guano. The upshot of the whole is that, practically, so far as artificial manures are concerned, we need not dwell upon mineral ingredients, but must give ammonia to wheat, and to turnips phosphorus. Under what circumstances of soil or weather ammonia even injures turnips remains for further inquiry; for good farmers give them guano, rape-cake—nay, near Manchester, sulphate of ammonia itself; and a neighbour* of mine has raised fine turnips with sugar-dross, in which the blood, that is, nitrogen must be the active principle: so does also the important question, in what degree carbon (the straw of our dung) is beneficial to them. Though the mineral theory has passed away, it has left behind an indifference to carbon. Liebig, however, admits that woody matter, decomposing under a seed, feeds it until it can derive its carbon from the atmosphere. Boussingault extends this action to all the stages of growth. I am inclined to suspect that carbon, even in small quantities, is a much more active principle than we suppose. There is the case of bituminous clay improving a grass field in Wiltshire.† In Trinidad, decomposing mineral bitumen is said by Lord Dundonald to have a strong manuring effect. These act probably by their carbon; as also must oil,

* Mr. Goodlake, of Wadley, has for two years tried this manure, at the rate of 1*l.* 3*s.* 6*d.* per acre, against twenty loads of dung. The rows being intermixed, and the crop quite level, it was only by pulling up the swedes we could ascertain how each row was manured.

† See Mr. Gowen's account of it, Journal, iv. 276.

which is said likewise to fertilise. Water, too, containing carbonic acid, has a special effect upon grass.* The question, we shall see, has a vital bearing on the use of liquid manure. At present, however, we can only say that the three leading principles of manure are,—

1. Ammonia;
2. Phosphorus; and probably
3. Carbon.

But a word may be said as to the preparation of these two cardinal elements, phosphorus and ammonia. Phosphorus in bones is sluggish and does not go to work. Ammonia is volatile and flies away. Now, to quicken phosphorus, Liebig has taught us to dissolve bones with sulphuric acid; a most valuable discovery. The acid is applied most conveniently to bones from which the gelatine has been burnt out, which is generally, I believe, done for other purposes; though bones have lately arrived from South America, ready burnt, for the convenience, I suppose, of carriage, but to the entire waste of the ammonia. But bones, if piled up wet in mould,† may be also in great part decomposed, and their action accelerated. This process is also in strict accordance with the laws of chemistry; for Liebig says,—

> "Bones become warm when reduced to a fine powder; and moistened bones generally heat and enter into putrefaction; the gelatine is decomposed, and its nitrogen is converted into carbonate of ammonia and other ammoniacal salts, which are retained in a great measure by the powder itself."

If mould be added, as I recommended, the ammonia will nearly all be retained, and goes into the earth in readiness for the next corn-crop. I should still use some superphosphate, because it acts quickest. But it sometimes seems to act even too quickly, leaving the turnip aground in the midst of its growth. The half-reduced bones, if drilled in a mixture, would then take up its work and finish the root.

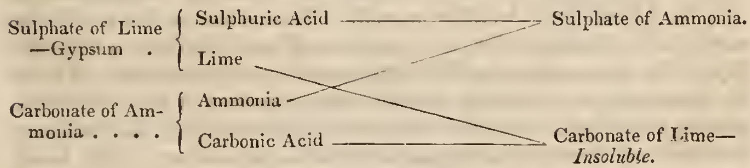
To fix ammonia is the other great lesson taught by Chemistry, and gypsum is often prescribed as the means. Ten years ago I tried gypsum for this purpose, but unsuccessfully. Ammonia was escaping largely from the litter of a farmyard, as could be perceived by the common test of holding near the surface paper dipped in spirits of salt, which turns the invisible fugitive into a white opaque steam of sal-ammoniac. A whole bushel of gypsum was strewed over a few square feet of the yard. The test showed that the escape of ammonia was uncured. We have been also advised to strew the pavement of stalls with gypsum to sweeten our stables. The remedy was applied in my own, but the stables not sweetened. A caution concerning gypsum was therefore in-

* See account of Swiss Water-meadows, in the present Number.

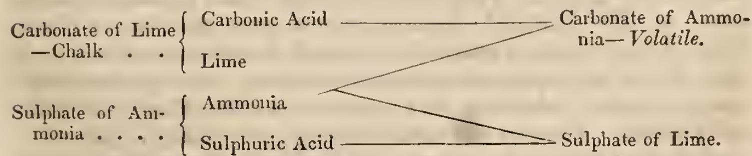
† Pusey, On a new mode of preparing Bones for Manure.

serted by me in this Journal. Still it was said gypsum must be a fixer because it is sulphate of lime, and if sulphate of lime be mixed with carbonate of ammonia, the sulphuric acid quits the lime, seizes the ammonia, and holds it fast as an inodorous salt. Accordingly, gypsum has kept its character to this hour as a "fixer," and farmers have been much blamed for not using it. Boussingault, however, throws a new light on the matter, though in discussing another subject.* He says that gypsum in *solution*, as in a laboratory experiment, does act as desired, but that in a state of *moist powder* the gypsum is indifferent towards ammonia; nay, more, that in that state the law of affinity is reversed, and that carbonate of lime, chalk, decomposes sulphate of ammonia, actually *unfixes* it. To explain this contradiction he quotes Berthollet and the following singular law. If two saline solutions, containing between them an insoluble salt, be mixed, that insoluble salt will be formed: but if two salts, containing between them a volatile salt, be mixed in a moist pulverulent state, the volatile salt will be produced. Thus, sulphate of lime and carbonate of ammonia in *solution* produce carbonate of lime insoluble, leaving sulphate of ammonia, which is soluble, though not volatile. But carbonate of lime mixed with sulphate of ammonia in a state of *moist powder*, acting by an opposite interchange, produce carbonate of ammonia, a volatile salt, and sulphate of lime. The following diagrams will show at a glance the contrary changes.

Solutions mixed.



Moistened Powders mixed.



Gypsum, then, unless in solution, will not fix ammonia. But it requires to dissolve it 500 times its own weight of water. Therefore, when it is proposed that "every farmer should use a waggon-load of gypsum each year," we see that 500 waggon-loads of

* Boussingault's Rural Economy, p. 442, Eng. Edit.; see also Fownes's Elementary Chemistry, p. 195.

fluid are necessary to make that quantity act,—a bulk of fluid scarcely attainable. Unless, therefore, gypsum find the requisite amount of liquid, which in a stable must be very doubtful, its action will be precarious; and again, how can we be certain that when evaporation takes place the process may not be reversed—be succeeded by the contrary action, as between salts in the state of powder, and thus the ammonia fixed in the yard be released again in the dung-hill? Green vitriol has been proposed, but Sprengel* proves it to be too expensive. "For 23 lbs. of ammonia so prepared require 53 lbs. of sulphuric acid, and 100 lbs. of green vitriol contain only 29 lbs. of sulphuric acid." Now, green vitriol or copperas costs from 5*l.* to 6*l.* per ton. The cost of sulphate of ammonia so made would be about 12*l.* per ton, which price brings out pure ammonia at about 6*d.* per lb. Now, when guano is at 10*l.* per ton, the present price, the ammonia in that form costs only 5*d.* per lb.;† so that a farmer using green vitriol as a fixer buys of himself for *six* pence what he could purchase in the market for *five*. Of the so-called "fixers," then, gypsum is uncertain, vitriol costly, alum doubly so. There remains sulphuric acid, but this last may be reserved until we come to the treatment of dung.

The management of ammonia in the yard is still dark and difficult. Its management in the field is simplified by an important discovery of Mr. Thompson's,‡ which Mr. Way's § experiments have greatly enlarged and diversified. If you pour a solution of ammonia on loamy soil, the water when it escapes below will be found free from ammonia. This action is not at all the same with filtration, for if a portion of soil be thrown into the liquid the ammonia equally disappears in a few minutes. There is, therefore, a chemical action, and it seems a new chemical action, reversing, as under the law of Berthollet, the ordinary conduct of chemical substances towards each other. The loam thus arrests, not ammonia only, but everything which can serve as manure for plants. Putrid urine, sewer-water passing through loam, as Mr. Huxtable found, become pure as well as clear. Thus, a deep loam is enabled to retain manure committed to it until the future crop requires nourishment; an important discovery, limited indeed in its application, as Mr. Thompson candidly shows. For the soil must be *deep*, since dung is generally ploughed in four inches deep, and twelve inches at least of soil should be under the dung to secure "absorption." It must be a *loam*, too, for sand has not this property.

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* On Animal Manures, vol. i. p. 470.
† Way on Value of Guano. Journal, vol. x. p. 225.
‡ On the Absorbent Power of Soils. Journal, vol. xi. p. 68.
§ On the Power of Soils to absorb Manure. Journal, vol. xi. p. 313.

Such are the scanty lights thrown lately by chemistry on the culture of crops, but the principles on which animals are nourished have been suddenly brought into full day by the brilliant discoveries of Baron Liebig. That great chemist has shown that the stomach of animals does not compound their flesh from the ingredients of their vegetable food, but finding that flesh ready formed in the corn or hay, merely selects and appropriates it. This substance, called gluten or albumen, resembling the white of an egg, is found generally in food. "Chemists," says Dr. Playfair,* "were surprised to discover that this body never varies in composition, that it is exactly the same in corn, beans, or from whatever plant it is extracted. But their surprise was much increased when they remarked that it is quite identical with the flesh and blood of animals. It consists of carbon, hydrogen, nitrogen, and oxygen, and in the very same proportion in 100 parts. So much so," he goes on, "that if you were to place in a chemist's hands some gluten obtained from wheat-flour, dry albumen from an egg, a fragment of the flesh of an ox, or of dried blood, he would tell you that they are precisely the same." He adds the following analyses:—

	Gluten from Flour. Boussingault.	Casein from Peas. Scherer.	Albumen from Eggs. Jones.	Ox Blood, Playfair.	Ox Flesh.
Carbon	54·2	54·138	55·000	54·35	54·12
Hydrogen . . .	7·5	7·156	7·073	7·50	7·89
Nitrogen	13·3	15·672	15·020	15·76	15·67
Oxygen	21·4	23·034	22·007	22·39	22·32
	100	100	100	100	100

Analyses not differing from each other more than the analyses of the same substance usually do. The gluten or casein of the flour or peas, which we may call fibrine, taken into the stomach, and thence into the veins, becomes blood, and the blood passing from the veins becomes flesh, without change, just as a house is built up with stones from a quarry. The muscles of the ox are woven invisibly from the fibrine of grass, as linen visibly from the fibres of flax.

This is an undoubted truth, and a great discovery of Liebig's. Another discovery is so well known that it need only be mentioned. Besides fibrine, which becomes meat, vegetable food contains other substances, gum, starch, sugar. All these are without nitrogen, and consist of charcoal (*carbon*), with the elements of water (*oxygen and hydrogen*), that is of the substance of wood. Liebig has shown that in the animal body they are used as wood, being absorbed, combined with oxygen, and exhaled as carbonic acid. In the words of Dr. Playfair, "The body is the

* Applications of Physiology to the Rearing and Feeding of Cattle. Journal, vol. iv. p. 215.

furnace—the food is the fuel—the excrements are the ashes—and the gases exhaled from the mouth are of the same composition as those which fly up the chimney of the furnace." If, then, we want an animal to lay on meat, we give him beans, which abound in fibrine, and chopped straw for fuel, just as we ourselves eat beef-steak and potatoes. Animals seem to know this by instinct, for my shepherd tells me it is useless to give the sheep chaff in their troughs until cold weather comes on. As the winter deepens they eat more chaff, but in spring gradually leave it off, till in May they refuse it, as we light our fires at Michaelmas and leave our grates empty in May. So far all is clear, but an unfortunate doubt remains on a point, all-important too in feeding cattle, namely, the source of fat. According to Liebig it is the surplus of the starchy matter in food, which, not being wanted for fuel, is not consumed, but deposited in the body ready for future use. Dr. Playfair compares it to the consumption of coal in a gas retort, where, if there be not air enough present, a part of the coal instead of passing off as gas is left behind as coal-tar. The tar formed in this case, says that agreeable writer, represents the fat of animals. If this be so, we have only to supply our fatting hogs with food full of starch, like potatoes. But the greatest agricultural chemist, Boussingault, takes a different view altogether. He denies that fat is ever produced in the animal frame from starch. He shows that the food of cattle contains a third substance, vegetable fat, and is positive that as the flesh of animals exists ready formed in their provender, so does also their fat, and so also does the butter contained in their milk. On the latter point he brings this proof, that a cow, namely, being fed on mangold-wurzel alone, which contains little fat, gave but little milk, and that milk poor, but recovered her milk on receiving straw in addition, which, little as we should suppose it, contains vegetable fat. Since fat is the object principally aimed at in preparing stock for the market, the muscles or flesh having often, I suppose, attained their full size when the beast is put up to feed, it is evident that, until the source of fat be determined, organic chemistry being undetermined itself, can give no certain judgment on the final feeding of stock. I mean that we can have no reliable tables of the comparative virtue of different kinds of food; because, if Liebig be right, there must be two columns of figures, 1, for the ingredients of flesh,—2, for those of fuel and fat jointly; but if Boussingault, Dumas, and the French school be right, then we must consider each article of food under the three heads of flesh, fuel, and fat distinctly. There is one point, however, certain—the importance of warmth. Wherever fat come from, there is no doubt that both fat and flesh are wasted from the production of beef in an animal frame suffering by excessive cold. The substance of an

animal pining from cold evaporates with the breath, as the spirit would pass from wine in an uncorked bottle. The comfort of our stock, therefore, is in unison with their master's profit. As to their food, practice, as Boussingault himself, no mean chemist, frankly says, "has got the start of theory; and I own," he adds, "with perfect humility, that I think its conclusions are in general greatly to be preferred." Still, animal chemistry has made great advances, and does at least *explain* much. Of vegetable chemistry as much can scarcely be said. In the words of its able exponent, the late Dr. Fownes, speaking at the premature close of his labours, "The chemistry of vegetable life is of a very high and mysterious order, and the glimpses occasionally obtained of its general nature are few and rare."

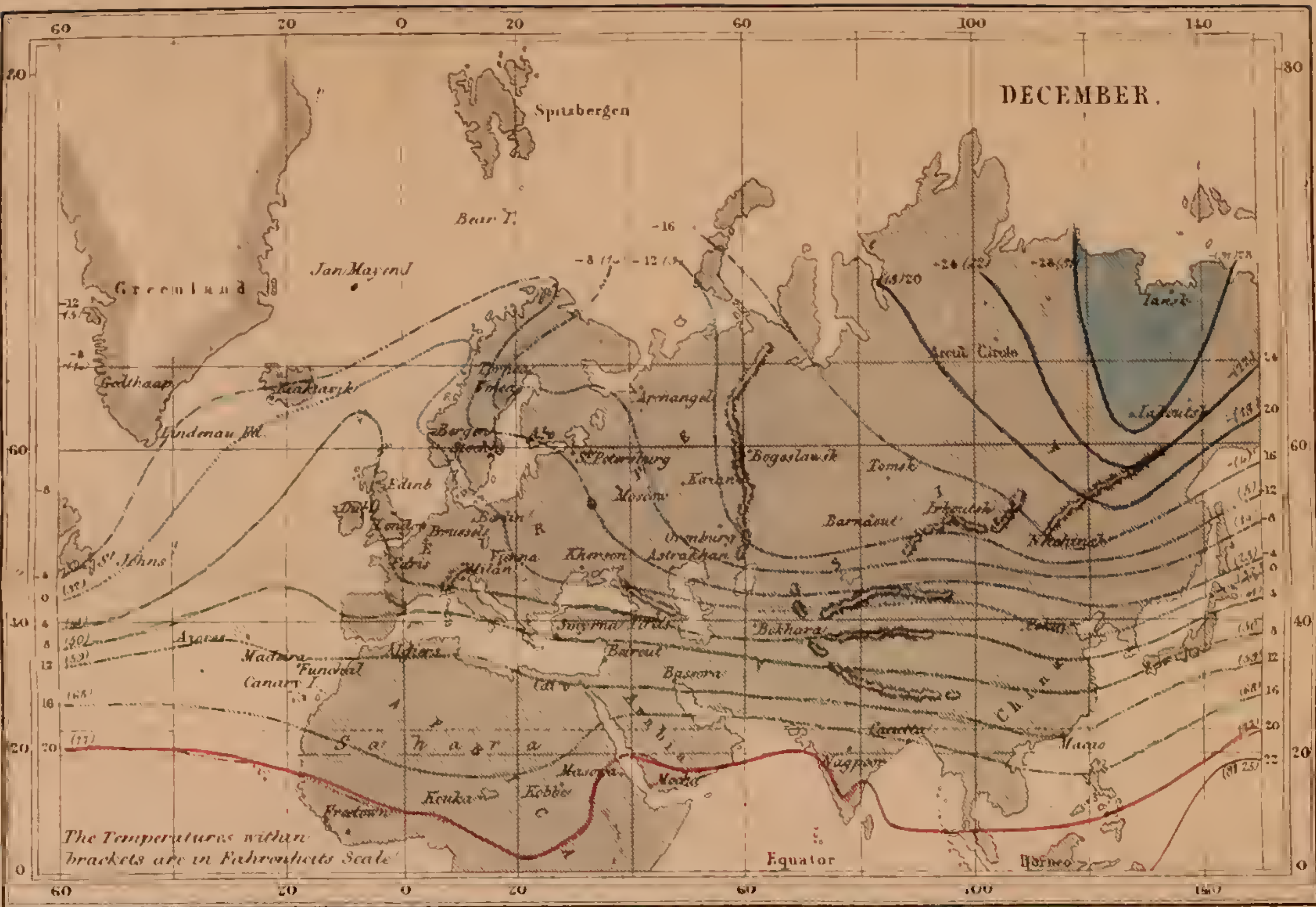
It seems at first strange that the chemistry of the lower form of life should be more backward than of the higher—that vegetable nutrition should be darker than animal: but Liebig's discoveries afford us a reason. Animals, he has proved, find much of their substance ready made in the vegetables which they consume. Besides, animals and vegetables belong both to organic chemistry. The two substances are, as it were, of the same realm, subject to the same laws. But vegetables have the task of transmuting the dead elements into living matter. They bridge the gulf between the mineral and the organised world. Now this union has not yet been effected between the two kinds of chemistry. In mineral, or more correctly, inorganic chemistry, if we can decompose a substance, we can generally also compose it. If we can sever water into its two gases, we can form water again by uniting those gases. But we cannot deal so with oil: we can only unmake it; we cannot form it anew, by blending its elements. That task is left to the hidden powers working in plants. Again, ammonia, the very substance we prize so highly and purchase so dearly, is compounded of two gases, very common and very attainable; for one of them, hydrogen, forms one-ninth of all water, and the other, nitrogen, three-fourths of the very air that we breathe. Yet, because organic chemistry cannot put together these two gases, in which all nature lives, and so form ammonia, our ships are compelled to double Cape Horn and fetch guano from the Pacific Ocean. If, then, we cannot compound the simplest organic substance, by mixing its two or three lifeless constituents in our vessels, being thus confessedly ignorant of the laws under which they combine, what wonder that we should be unable by any chemical reasoning to perform the same task in the garden or in the field. It seems reasonable, therefore, that we should earlier scan the laws of vegetable than of animal nutrition; understand, that is, the food of beasts sooner than the food of plants.

The mineral theory hastily adopted by Liebig has broken down; no other has taken its place. Our best authority, Mr. Lawes, has established certainly so much, that of the two active principles in manure, ammonia is specially suited to corn, phosphorus to turnips, and that turnips are *probably* benefited by the woody matter of straw. But vegetable chemistry, having no fixed truths of her own as to the sources from which plants derive their food or the mode in which they appropriate it, is not advanced enough to lay down laws for farming, or sit in judgment on its established practices. Except Liebig's suggestion for dissolving bones with acid, and Sir Robert Kane's for using flax-water as manure, I know no agricultural process arising out of chemical discovery. The more we value the labours of agricultural chemists, the more warmly we look forward, as I do, to their future progress through the patient examination of existing practice, which is itself the accumulated and varied science of ages, the more we should discourage undue expectations of immediate advantage. It is a great mistake to suppose that men can be made farmers by teaching them doubtful chemistry. But are we, therefore, to abandon agricultural chemistry because it is yet doubtful, and has not yet brought forth more fruit? Rather let those who are able cultivate it the more diligently by careful experiments, that step by step we may reach more certain knowledge hereafter. No one, meanwhile, can doubt the high value of Mr. Lawes's experiments in the field, or Mr. Way's* researches in the laboratory. I should not have said so much, but that the public are sometimes led by a false estimate of chemistry to undervalue our real progress in other sciences, as in mechanics, and to overlook the true knowledge of our practical farmers. Before we pass to these, however, I must endeavour to do justice to our advance in what seems the most uncertain of all sciences—

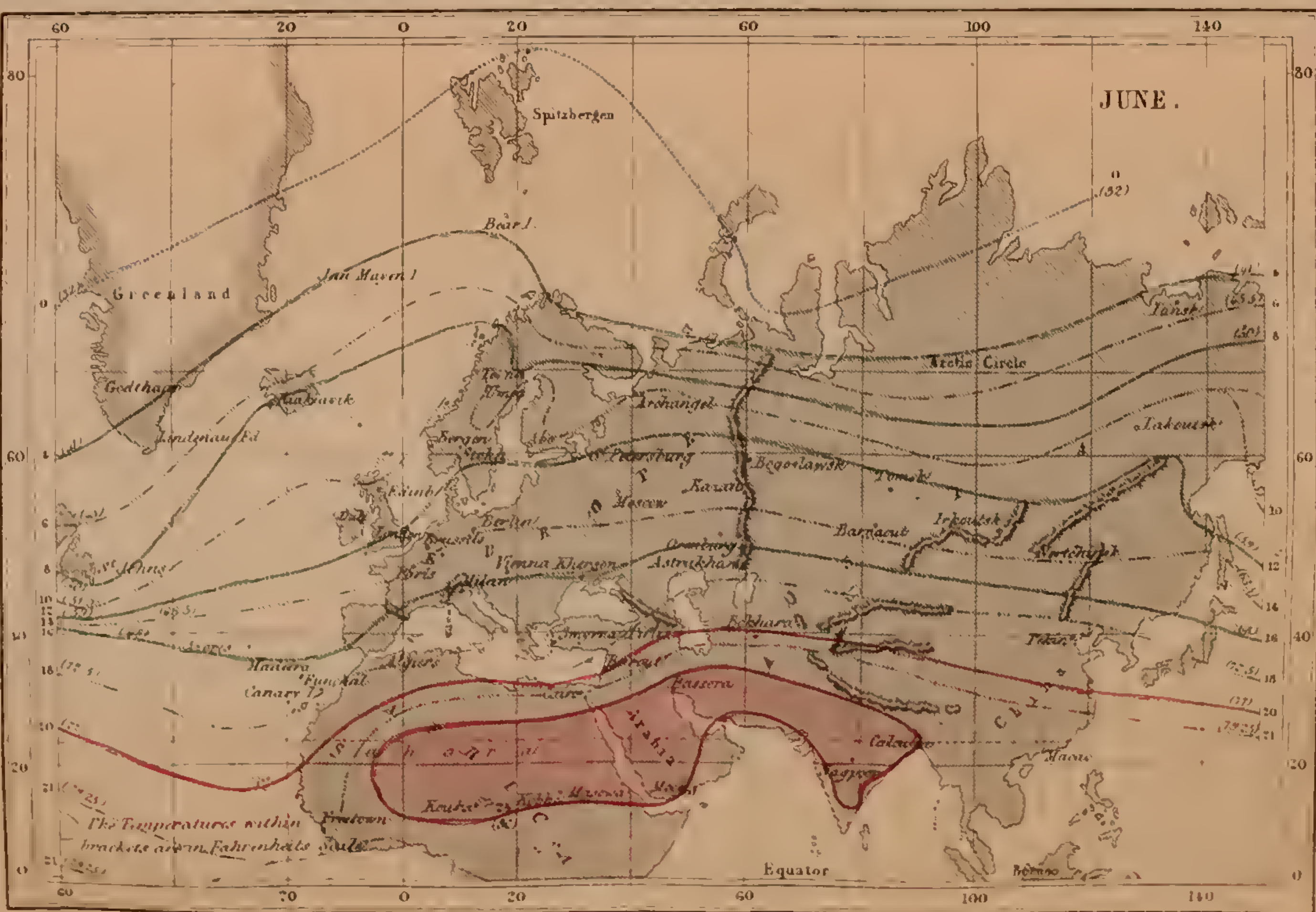
Meteorology.

Much light has lately been thrown on climate; and our own, which was once so much complained of, is found to be the best in the world for healthful exercise, and, as I believe, for farming also: because it enjoys the most temperate summer, combined with the mildest winter, and, on the whole, a steady down-fall of rain. No one can have returned from Calais to Dover without admiring the refreshing verdure of the English downs. This we owe to our frequent showers, to our clouded sky, shielding off the scorching sunshine, and to invisible vapour diffused in our air. The excess of vapour is shown by the difficulty of growing in French greenhouses the heath, a plant requiring moist air, and the difficulty of working the English electric telegraph. This moisture

* See Mr. Way's excellent paper on Guano. Journal, vol. x., p. 196.



The figures marked thus + denote the increase of Cold
The tract colored pale blue in Siberia is the region of extreme cold in December



The tract colored red is the region of extreme heat in June

Standidge & Co Litho 36 Old Jewry.

arises partly from our neighbourhood to the sea on all sides, partly to the prevalence of western winds arriving from a wide ocean. Hence comes our grazing husbandry. Our equable distribution of warmth through the year gives us our peculiar farming, mixed husbandry, the extensive growth of roots upon corn-land, producing meat largely as well as bread, the maintenance of stock thus supporting the production of corn. If our summers were hotter, we could not grow turnips; if cooler, they would not ripen wheat. If our winters were colder, turnips would perish. Our forefathers, indeed, did not practise root-husbandry. On the eastern side of England they took two corn-crops and a naked fallow, which is the three-course shift still lingering in Cleveland, and prevailing in Prussia. This is the corn side of England. On the west side, you may still find in secluded parts of Wales, or in Devonshire, three or four oat-crops grown in succession, and the land left as many years covered with grass. This is the grassy side, and though the turnip has now overspread England, one side of the island is still best suited for corn, the other for herbage. This difference of produce rests on a difference of climate, the causes of which are well understood, but are found in very remote parts of the globe. Heat and cold, long continued, accumulate in regions removed from water, because the land there becomes constantly hotter or colder whilst the influence of the sun remains strong or weak, and the wind from the sea, which varies less in temperature, scarcely reaches these inland tracts to mitigate the fierce extremes. Hence the coldest part of the old world is in the centre of Siberia. As you recede from that point westward you approach the sea, and hence in winter our cold comes with north-east winds from Siberia, the great deposit of cold. But we have happily a distant yet effective source of warmth also in the Gulf of Mexico, from which the gulf stream washes our western shores. This great warm-water apparatus of nature passing even beyond us stretches northward of the north cape of Europe, and there, accordingly, though so near the pole, the coldest wind of winter comes actually from the *south*-east. Hence, as is shown in the annexed extract from Professor Dove's chart, the line of equal cold during December runs in Great Britain due north and south. Hence, the meadows are brown in Essex, while the grass grows till Christmas in Devonshire. Englishmen, indeed, do not know the mildness of an English winter. London, though on the cold side of England, is less cold in January than Paris or Milan; and though they go for warmth to the south of France or to Italy, deserted Mayo and Connemara, and the shores of Killarney, covered with arbutus, are warmer than Montpellier, or Genoa, or Florence. Such is our winter climate. But as spring advances a new cause of warmth arises. The sandy deserts of Africa and Arabia, gathering heat, begin to glow like a

furnace, and dart warmth northwards across Europe. Germany lying nearer to the centre of this burning wilderness becomes warmer than England, which is now also cooled comparatively by the sea that warmed it before. So that whereas in winter the more you advanced east towards Russia the deeper became the snow, now you find it more and more sultry. Hence, Hock is grown in the latitude of Cornwall. The lines of equal temperature now run up in the map to the north-east. Stockholm and Petersburgh in June are as warm as London. Hence, the east side of England, being the warmest in summer, is the best side for wheat. But, besides the mild winter on one side, and the warmer summer upon the other, there is a yet greater difference as to moisture visible and invisible. In Devonshire you find fern growing on the limbs of the oak, and oaks themselves thriving on the top of high narrow hedgebanks. The air, though clear, being moist, probably absorbs less water from the surface of leaves, which therefore require a less supply of water through the roots. The difference, too, as to visible moisture, rain, is very great indeed; for, the westerly winds arriving from the warm gulf stream, charged with vapour, are chilled by the land and part with that vapour in rain. If they strike a hilly land (and our western coast is almost mountainous) the air is driven up from the level of the sea to a higher and colder region, and parts with yet more rain. Accordingly, taking 29 places * on the east side of the island, we find the yearly downfall to be $25\frac{1}{2}$ inches; and at 29 places on the west side to be 49 inches, all but double; while on the Cumberland mountains it reaches the enormous amount of 121 and 147 inches. In Northumberland, when a south-wester blows, they know, I was told, that it is raining torrents in Cumberland, 50 miles off, but they get none themselves, because the air has been dried in rising over the mountain tops.

What then is the practical inference for agriculture from these undoubted facts, established by Science? Caution in laying down general rules. We now see why a Scotch farmer often fails in England, or a Suffolk farmer even in Cheshire. Again, if a landowner desire to improve his estate in the West Highlands or Galway, he must look, we see, not to Lincolnshire or Aberdeenshire, but to some district of kindred moisture. There is, however, a more definite inference to be drawn even than these. How can a fixed rule be laid down for the depth or the distance of drains or the size of the pipes, when one county has 25 inches of rain and another has 50 inches to be carried off by those drains? The difference is, in fact, more than this; for a large part of the downfall returns to the air from the surface. According to the most recent and trustworthy experiments pub-

* I have taken the places given in Mr. Whitley's paper, Journal, vol. xi. p. 13.

lished in this Journal by Mr. Charnock, out of 33½ inches of rain, no less than 25 inches are evaporated, 8½ inches only reach a depth of 3 feet, and therefore pass through a drain. This was in Yorkshire. But at Kendal there fall 54 inches of rain. The evaporation there, however, would be not more, but less, because the air being moister must dry what is exposed to it more slowly, and the evaporation would not exceed, probably fall short of 21 inches. There remain, therefore, for the drains 33 inches depth of water in this case, 8½ inches only in the other—four times as much in Cumberland as in Yorkshire. Yet, hitherto, if a man living in Oxfordshire said that inch pipes would drain his land well, a voice from Ayrshire might exclaim that it was absurd to use less than 1½ pipes, which he found far the best. Yet, the smaller pipe might be more competent to its duty in one place than the larger one in the other. The same thing may be said of farmyards. Living in one of the driest counties of England, I adhere to the old fashion of making muck in farmyards. This was somewhat blamed by a northern writer whose talents I sincerely respect. At the very time, however, we were obliged to use a fire-engine to moisten the litter, which was growing white and mouldy for want of moisture. When it rains here in winter our labourers say, "This is fine weather for making dung." Henceforth, in speculations on the agriculture of the country, we must never lose sight of our material variations in climate.

Agricultural Mechanics.

This is certainly the branch in which the increase of knowledge has done the most good to farmers, that increase being partly extension, partly advance. Ten years ago it was shown by me in this Journal, that even in the same parish on the same soil one farmer's plough was heavier for three horses than the other farmer's for two. In many parts of England you might then see three horses ploughing light loam: such a thing could scarcely be found now. It appears from official records that the number of agricultural horses has been greatly diminished in the last few years. The account* of the number of horses claimed as "wholly exempt from Duty," as being kept and used solely for the purpose of husbandry, stands as follows:—

Year.	Number of Horses.
1840 . . .	371,937
1848 . . .	297,858
Decrease .	74,079

* It should be stated that as the claim for exemption is not compulsory, it is possible that fewer of the horses actually kept may have been returned, but there is no reason to think that this has been the case.

Now as more land was certainly broken up during that time than has been laid down to grass, I can see no other cause of the decrease than the reduction of plough-teams; and if so, putting the expense of each horse at only 10*l.* a-year, though it is set sometimes at 20*l.* in those fanciful statements, the estimates of farm expenses, we get three-quarters of a million saved yearly to the farming body at large. I believe that two-horse ploughing can be carried no further; it is a mistake to suppose that clay land can be worked by two horses abreast, one of them stepping on the whole land and poaching it at every step; and it is far better that three or four horses should draw at length in the furrow. But there is a similar change which gives a yet greater saving of horses, which has been proved to do so over and over again in this Journal, which might be used almost everywhere; but about which farmers have been, to say the least, rather slow. I mean, of course, the exchange of waggons for carts. In Northumberland light carts with a single horse are used for all farming purposes. In Bedfordshire they have light carts too. In the south we have well made waggons; but with three horses. The Lincolnshire waggon is like a railway-truck on the broad gauge. I will not again describe the trial in which five of my horses with carts beat ten horses with waggons at barley cart, the number of men being the same; but here is another trial which has just taken place, with the same numbers and the same issue, on the challenge of Sir John Thorold, at Grantham, this year.

"The trial was made to-day [Aug. 27], in a field of mown oats on Mr. Fisher's farm. The extent of the ground cleared is twelve acres; the crop was a heavy one, and the distance from the stack-yard is a mile and a quarter. On the way, the river Witham is crossed by a ford, and the approaches on either side are steep and almost frightful. As in the former case, the men and boys were equal on both sides, and the number of waggons and of carts on either side was *five*. The *horses* used in the carts were FIVE, while those used in the waggons were TEN. The time occupied in clearing the ground was four hours and three-quarters. *Both parties began and finished together*, and it was found, by measurement of the stacks, *that the carts had conveyed about two loads more than the waggons*.

"The trial of last week proved favourable to carts on *level* and *up-hill ground*, while this day's result is equally favourable for both *up-hill and down*. In going down to the river, it was found necessary to lock a wheel of the waggons, and to arrange the horses so as to allow of an additional leader in going up; while the carts went straight on, without stop or change of circumstances."

The saving of horses by the use of Northumberland carts, it is now quite clear, is one-half. What is the saving of outlay at the wheelwright's on entering a farm? I have obtained the prices of the old conveyances from a village wheelwright; they are as follows for a farm of 200 acres:—

Old system.

	£.	s.	d.
3 waggons, at 35*l*.	105	0	0
4 3-horse dung-carts, at 14*l*.	56	0	0
	161	0	0

New system.

	£.	s.	d.
5 one-horse carts at 11*l*. 10*s*.	57	10	0

so that the new plan costs but one-third of the old fashioned outlay. The carts are Busby's prize carts, suited for all purposes: easy for the horse, as the wheels are rightly made, easy for the labourer, as they are much lower than other carts, and wonderfully cheap, as they cost but 11*l*. 10*s*., while for my own I paid 18*l*. 18*s*. a few years ago. Here, indeed, since farmers have compared the two systems, no one buys waggons in stocking a farm; but those who have waggons do not like to buy a new set of carts. I should say they had better sell their waggons while they can, and if they cannot, make a bonfire of them. To use them still, is like running a stage-coach in these days between London and Bath. Altogether we must admit, that though thousands of new implements are sold every year, the farmers in some counties are tardy in enlarging the old circle of plough, harrow, and wooden roller. There is Crosskill's clod-crusher, which reduces, as its name imports, cloddy land. Sometimes a field is kneaded by sheep on turnips in wet weather, and ploughs up in brickbats, among which barley cannot be sown. I have seen women employed to break them with sticks. A clod-crusher would do it at once, costs but twenty pounds, and lasts for ever. It is the best presser for a honey-combed wheat-field in spring, as the dints from its teeth, like the footmarks of sheep, stop the course of the wire-worm. A grubber too, such as Biddle's, or the Uley cultivator, covers with its tines the width of 8 ploughs, requires but 6 horses instead of 16, and on some occasions does the work as well or better. Drills are become pretty common in farmers' hands; they are greatly improved, and perhaps the only improvement still required in them is a reduction of price. Among these, the most striking novelty is Chandler's water-drill,* which bids fair to remedy a great evil for southern farmers. Often when our land in July is ready for the turnip-seed, on the success of which depends our flock's subsistence in winter, that land is as dry and dusty as a turnpike road. We watch vainly every cloud and in vain set our weather glass. Weeks pass without rain, or worse still, a shower falls, but we find that the rain has not entered the ground. This drill, however, deposits along each

* See commendations in Implement Report.

line of seed enough water, which serves also as a vehicle for manure, such as superphosphate, to start the young plant in readiness for the coming change of the weather. It is used extensively by practical farmers in Wiltshire, and bids fair to remove for the root-crop one of the farmer's peculiar obstacles—uncertainty; to remove which, if there be a leading object of improvement in agriculture, is the main object. There is another implement, however, for turnips, the most beautiful, I should say, in its work of all the new implements—I mean Garrett's horse-hoe. It is a good plan in the south of England to sow the seed in four rows at once, with a corn-drill, which covers 6 feet in width. But when the turnips are up, the difficulty often is to get them hoed, the hands being busy with harvest. This horse-hoe is made to cover the same width, so as to follow any swerving of the drill, each of the hoeing-knives works independently; the holder, by help of a steerage, drives fearlessly through the surface of foliage, though the leaves almost meet, and you may afterwards see the green surface lying in bands of dark green or of grey, as the leaves have been laid from the spectator or towards him. The same implement will even hoe wheat, though the lines of plant be but 7 inches apart, and the row of knives passing along threaten total destruction. For a field operation, it is as delicate as the action of the revolving knives with which the loose threads are shorn from the surface of broadcloth at Leeds. I have had Garrett's horse-hoe long, and wonder that any south country farmer who knows it should be without it. It must be made to fit the width of the drill. It is marked, I see, at 18*l.* only. These new implements would not all together cost the difference between the price of one-horse carts and of the waggons, in buying which we purchase the privilege of using ten horses where five would do better. Again, why is the horse-rake, a cheap implement, used generally to dispatch the harvest in one county, unknown or disliked in another? A good paring plough has long been wanted to scarify the stubbles in September. We have now a perfect one, Kilby's, which won the prize at Norwich and Exeter, costs but 5*l.*, and pares the land as true as a breastplough, twice the width of a common plough, yet drawn by two horses only. Such are a few of our principal field-implements. In yard-machines, too, mechanical science has helped us greatly. Without trespassing on our excellent Implement Reports, I may cite the moveable steam-engine, which has this great advantage over a fixed engine, that the fixed engine requires all the corn to be brought home to one central yard, be the farm ever so large or ever so irregular in its form; now two miles out and back at harvest and dung-cart are a serious increase of horse-work, and every large farm, therefore, should have a field-barn, to

which the engine itself may travel. A small farm, again, cannot keep a fixed engine in work. It is most convenient when a corn-rick is to be threshed in a hurry, or a straw-rick to be cut up for sheep, that steam-power should be at your command, to be had for the hiring. Accordingly, fifty moveable steam-engines at the price of 200*l.* each were sold in the following year by one exhibitor at our Norwich show. Their improvement is manifested by the single fact that our prize engine at Exeter consumes but one ton of coals, in the time during which a prize engine of former years requires four.

But, apart from steam-power, there is a surprising difference in the amount of work done by common threshing-machines worked by four horses. It would be unfair, of course, to compare the corn threshed in a barn with the result of the race at our annual trials. But I have reason to believe that the ordinary work of the best machines in the barn, striking an average of the yield from the straw, which varies, of course, at different harvests, is from 30 to 40 quarters of wheat per day of eight hours; yet I never could find from any farmer in my own neighbourhood that he could get from our common threshing-machine more than 10 to 15 quarters in the same time. I have seen it stated, too, that in Middlesex one of Messrs. Garrett's threshing-machines was found to double the work of the common machines of that county. Clearly farmers should look at once into this monstrous difference of their machinery—a difference which could not exist two years at Manchester. The threshing-machine, too, is now made to do more than thresh: it separates the straw, and, further, winnows the corn so far that a single dressing is afterwards sufficient to fit it for market. All this, Mr. Garrett informs me, may be done with his steam-driven threshing-machine at 1*s.* to 1*s.* 3*d.* per quarter; by hand it would cost certainly from 3*s.* to 4*s.*, so that here we have a saving of 2*s.* per quarter, 7*s.* on every acre of wheat. The quality of the threshing itself is greatly improved. To this day in some, perhaps most, districts, maltsters will not buy machine-threshed barley, because so many grains are bruised by our old machines, and their germinating principle destroyed. Farmers generally ought to know that this objection has been entirely overcome within the last few years, and that in Essex, as I am told—no mean district for malt—the maltsters are even beginning to buy machine-dressed barley by preference. In hand-threshing barley there is not only great delay in preparing any quantity for the market, but there arises a serious obstacle for one of our great modern improvements—the cutting up the barley-straw into fodder for sheep, into chaff, as it is called. The thresher, of course, gets through but a small quantity of barley in a day's work, and the straw is heaped up

gradually in the yard, where it is often spoiled by occasional showers. The machine completes a rick in a day or two; and one of our new chaff-cutters, worked by a horse, in a day or two more will cut up the loose straw into chaff, which, mixed with a little cake, is quite equal to hay. Nothing shows the progress of our machinery better than the process of cutting straw into chaff. Ten years ago it was done in a trough, with a chopper at the end, lifted up and pressed down by a man, who was paid for it at the rate of 2*d.* for a 6-bushel basket. Then came the various chaff-cutters with circular knives, still worked by hand. With these I used to pay 1½*d.* per basket—three-fourths of the former price; but, putting a horse to the chaff-cutter, I find a far greater reduction, for we cut at the rate of 544 baskets per day. The account stands as follows:—

	s.	*d.*
8 Women yelming, *i.e.* straightening, the straw, 8*d.*	5	4
6 Men, 16*d.*	8	0
Horse, say	2	6
Boy	0	6
	16	4

The cost comes out, instead of threepence, about a farthing and a half; and as Mr. Cornes's new chaff-cutter dispenses with the women yelming, we may safely set down the basket of fodder at a single farthing, instead of twopenee — one eighth only therefore of the cost incurred here twelve years ago. I cannot quit machinery without adverting to the deep obligation under which we all lie towards the gentlemen who, year after year, devote days of minute attention and hard labour to our trials of implements. To their reports the reader must turn for accurate information on the implements mentioned and on others, as the various crushers contrived for the economical use of food.

Medical science, too, has been applied to the diseases of our cattle by Professor Simonds, and no one can doubt, none at least who has felt the losses of live stock, that we shall gain much when we get our stock out of the hands of the farrier, and cow leech, and pig-doctor. But I must hasten on, and proceed at once to

The Improvement of Land.

Ten years since nothing struck me so much as the varied means possessed by the owners of land in England for raising, permanently, the productiveness of their estates. In no country are those means so various. Scotland and Flanders are monotonous in contrast with England. In none has so much been effected. And after ten years' labour the same thing still strikes me as forcibly. It is on these recognised practical im-

provements that our dependence, I firmly believe, must be now placed. Not only too have we these *varied* means, but most of them are very *cheap* means. They would average three or four pounds an acre, and the crops are increased by them, be it remembered, without increase of the tenant's outlay. I know no other safe investment in which moderate expense produces so large a result of *profit* as in many of these permanent improvements of land. At the present time, however, the landlord's anxiety is to avoid permanent *loss* of income. He should, therefore, raise the productive power of each farm, and there are very few farms on which the owner, consulting with the tenant, may not find some effective and cheap improvement to make. We may begin with

§ 1. *Draining.*

No one now doubts the advantage of draining; but sometimes, unfortunately, the doubt exists whether it can be done—that is, whether you have an outfall. In Ireland this matter has been attended to by the Board of Works, and the rivers or brooks have been deepened in order to secure outfalls to each property. It is called there arterial drainage—an absurd name, importing the reverse of its object, since arteries convey their fluid into small channels, whereas these main cuts carry theirs off. Trunk drainage it should be called. In England vast operations of this kind have been effected by private enterprise, especially in the Great Level of the Fens, where 600,000 acres,* some of them below high-water mark, have been drained by cuts and windmills, and steam-engines, and now are in a fair way to gain a natural outfall. But no one can have looked from a railway (railways generally following the lowest level) without observing many flat tracts where the water fills the ditches to the brink during the three winter months. The fenmen have just paid 150,000*l.* for an additional fall of 11 feet in 30 miles, and have agreed to contribute 60,000*l.* more towards the new works in the Wash, merely for the benefit which will arise to their drainage. Elsewhere the same fall might be gained in three miles for 150*l.*, and for want of it the fields cannot be underdrained.

What is most difficult is thus often done first, because a less amount of evil is not enough to overcome a far smaller obstacle, and so, as in this last common case, the supineness of all, or obstinacy of one, prevents all improvement. An Act was carried by Lord Lincoln enabling the majority of a district to overcome such resistance. I mention the fact because its existence is scarcely

* For a full account of these vast operations, see Mr. Clarke's Prize Report, Journal, vii. 80.

known, though trunk-drainage is a very general want in many parts of the country.

Under-drainage has been used in England since the great rebellion, as Lord Braybrooke has shown, has long been a common practice of our Eastern counties, and received a new impetus from the late Mr. Smith, who coupled with it subsoil-ploughing—a practice which, in his rainy country, was probably right on certain soils; but which, on the dry side of England, is I believe frequently useless, especially on our strong clays, where the clay in three or four years completely closes again. On the other hand, where there is a pan to break through, subsoiling is sometimes enough without any draining. Up to this time the depth of drains was under three feet. It is to Mr. Parkes we owe the improvement of sinking them to four feet or five, and it does not detract from his merit if, as I believe, his rule upon the strongest clays suffers exception. I shall not enter on that debatable ground, but it is equally certain that shallow drains have been taken up, to be replaced by deep drains, and deep drains, in other places, been superseded by shallower ones. Draining, at whatever depth, for some years known to be profitable, is now indispensable, being only checked by want of means, and well it is that the cost of materials is so greatly reduced by tile-machines, which can deliver their goods, like the new printing-press of the 'Times,' at a score in a minute—that instead of paying for tiles, as I have done, 90*s.* for 1000 feet (60*s.* for tiles and 30*s.* for soles), we now get 1¼-inch pipes for 15*s.* —one-sixth of the former cost. Mr. Hodges' temporary kiln, too, should not be forgotten, which cost him 5*l.* only, has been used for six years, and will at least bring an unreasonable tilemaker to reason. Still we hear estimates of 5*l.* or 6*l.* an acre for draining, and that over a whole farm. The fact is, that we are too systematic in draining, especially when the work is begun upon a grand scale. The source of economy now must be in the maxim that "*one drain well laid to suit the circumstances will often save a dozen by rule.*"* Instead of saying that a whole farm shall be drained at 24 feet interval, unfold your plan as you proceed. When the outfall ditches are cut, you may find gravel bottom instead of clay; and a swamp of 40 acres may be drained, as was my own case, by an open ditch that cost 20*l.* Money is often wasted in over-draining. I speak from experience. In the same field there may be clay on one side requiring 30 feet interval, and loam on the other, where drains at 45 feet will be ample. To prove this I may give a few figures of the sums I am paying

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* From the Prize Report on Somersetshire.

this very November for drainage at different depths and intervals upon strong land:

Depth in Feet.	Labour per Pole.	Interval in Yards.	Cost of Workmanship per Acre.	Cost of Pipes per acre.	Cost per Acre.
	d.		£. s. d	s. d.	£. s. d.
5	4½	11⅔	1 8 4	17 3	2 5 7
4	4	11⅔	1 5 0	17 3	2 2 3
3½	3½	11⅔	1 2 0	17 3	1 19 3
3½	3½	15	0 17 0	15 0	1 12 0

A few shillings must be added to each sum for the main drain. These drains are in a clay subsoil, and clay is often the cheapest to drain, because it is easiest to work with the proper tools, but then a gravelly subsoil draws farther. The breadth of the ridges is a good guide to the right interval between the drains; for our forefathers shaped them to the quality of the soil. A drain, then, in each furrow will generally be enough; nor where the ridges are high would I attempt to level them. The crown of the ridge is long in recovering, the draining is less effectual, and besides, after all, the farmers are right in saying that more can be grown on a sloping surface than on a level one, that is, with an *equal depth* of soil; for the number of plants depends on the allowance of space to their roots.* Again, it has been said of late that drains should always go straight up and down hill. This is true, I believe, where the water to be drawn off is rain-water; but constantly a line of wetness may be found on a hill side, where the springs are thrown out, oozing through the field below. Draw your drain deeply along this line, and you will require no furrow drains lower down. Again, I know of my own knowledge that in this southern part of England grass-land may easily be overdrained; that consequently, where drains have been cut too thickly, every other drain has been blocked by the tenant purposely and properly. One field of good land was, I know, so much injured that the grass became of inferior quality, as was proved by its requiring only three days instead of four to make into hay—the effect of impoverishment in the sap of the grass. A most able agriculturist, to whom the fact was stated, could not believe it; but he lived in Cumberland, in sight of the mountains, which enjoy 124 inches of rain for our 24. So true is it here, that on my own meadows I have adopted the plan of damming the streams in summer. The water in the land consequently does not escape from the land, whilst the stream finds its way up the drains, and rises as in a sponge; so that this kind of subirrigation keeps the bottom cool and the surface green, while other meadows are scorched by the summer sun. I say, then, that if, avoiding system

* If any one doubt this, let him reckon how many rows of swedes, at a given interval, he can drill along the side of a hill, as compared with a flat.

in draining, you cut out your work to the substance of your land and its slope, draining should hardly ever exceed 3*l.* an acre all round, and should often be done for much less. A previous step, however, is often required :—

§ 2. *The Removal of Useless Fences.*

It is many years since this Journal first showed the evils arising from useless hedges and trees. Mr. Grant * by actual survey found that in ten parishes around Exeter, averaging 3000 acres, there were 5680 fields under five acres, and calculates moderately the loss of land at one acre in ten ; that is, at one whole of these parishes. In Broadclist alone there were hedges enough to reach from London to Edinburgh ; but in that parish they have been greatly reduced, and would now, I suppose, stretch little further than York. Devonshire is famous indeed for its small inclosures. But the next year, Mr. Grigor surveyed four square miles in four districts of Norfolk, and arrived at the same result there, an injury of 10½ per cent. from hedges and trees. With regard to trees, "The utter extinction of the land overshadowed by trees," said his informant, "would be gladly submitted to by every farmer, provided the trees were to be annihilated, and that without any diminution of rent."† By removing these fences and trees, then, in many districts landlords may add one-tenth to the size of their farms, for the injury is not at all overrated, as I know by experience ; since though it is now a very long time since my own internal fences have been removed entirely, I still find it useless to plough the land within five yards of a boundary fence full of ash-trees, and in Devonshire the roots of elms meet sometimes in the middle of the field, eating up altogether the food of the turnips. Every farmer knows the other evils produced by hedges. 1. They encourage mildew in wheat for a wide distance within the field—a most serious loss. 2. They harbour weeds, which spread their seeds through the fields ; and, 4. birds which devour the corn. 5. They occasion a serious loss of time to the ploughman in turning at the land's end, and make it almost impossible to use the larger implements, such as a drill drawn by five horses. Where hedges too are, there must be gates and gateposts—a serious item in the carpenter's bill. How far, then, can fences be dispensed with ? Where Down sheep are kept, which are always within hurdles or in care of a shepherd, they are utterly useless, and Down farmers certainly neither have them nor miss them. The owners of long-woolled sheep I know commonly divide their flock into small lots

* Journal, v. 420.
† On Fences, by J. Grigor, Journal, vi. 194.

in summer. Their attention I must especially call to a passage in the report upon Gloucestershire :*—

"On one farm the flock of Cotswold sheep used to be managed, running at large in separate fields, feeding on the young and old seeds. The number of ewes kept for many years varied from 100 to 110. The present occupier, seven years since, noticed the folding-off system practised in Wiltshire through the summer on vetches, clover, &c., and tried it a little at first, increasing as he felt the benefits. *His stock is now* 150 *ewes of the same breed, and the increase is owing wholly to the folding-off system.*"

What would be said if a manufacturer produced 100 pieces only of cloth while his neighbour turned out half as many more from the same weight of cotton? Yet so it seems to stand with our flockmasters through a wide breadth of England. Here is no outlay of capital wanted; no newfangled method,—nothing but a crowbar and a few hurdles. Our own practice, if recorded, I always believed, and still believe, can do more for us than even the discoveries of science. To return to hedgerows,—the expense of their removal has never cost me anything. The tenants have done it, and the fuel has paid the labour: the job of removing a hedge has even been sold to a labourer. But this will be otherwise where wood is plentiful or coals are cheap. The trees removed ought to help for other improvements. Unfortunately, the time has gone by for selling them, and as every one is now aware that they should be cut down, timber in many neighbourhoods is become a mere drug. At any rate, however, they will more than pay for the removal of fences, so that here must be one cheap remedy for country gentlemen. There is another remedy, perfectly costless, on which, as it belongs though not to the science, yet certainly to the practice of farming, I cannot but say a few words:—

§ 3. *The Diminution of four-footed Game.*

The rabbit is now admitted to be indefensible. He will clear by the covert side three or four acres of barley, which never comes into straw. He is self-convicted. But the hare will travel two miles out by night for his supper; and yet, though less palpable, the hare's bite is not the less mischievous. Even he will often feed down in winter or spring twenty acres of wheat, which comes to a crop indeed, but is apt to mildew, and is perhaps worse by a quarter the acre. Swedes, too, are gnawed and exposed to frost, so that farmers sometimes store their swedes for protection, not against the weather, but the nightly visitor. I have known farmers give up the growth of winter vetches altogether where hares have been swarming. The amount of loss may be measured in this case by the fact of a farmer's having been obliged, as I know, to send his flock twenty miles off in spring to water-meadows, for

* Bravender's Report on Gloucestershire, Journal, xi. 173.

the use of which he paid 60*l.*, instead of keeping them on vetches which he might otherwise have grown on his hired land at home. It is asked, indeed, sometimes, how many hares eat as much as a sheep? But the question is wrongly put. Sheep do not roam at will, or help themselves from the growing crop. A hog does not eat many potatoes, but who could bear loose swine in a kitchen-garden? A good farmer rated to me the injury on his land from hares at 5*s.* an acre. The excess, however, is now in course of removal: hares in moderation, pheasants, and partridges do no harm.

We may return to improvements in cultivation.

§ 4. *Burnt Clay.*

If there be any land which requires improvement, it is our real heavy clays; if there be a cheap and effectual mode of improvement for land, it is the burning of clay. The practice has been supported by varied evidence in this Journal: ten different papers have deposed to its efficacy, yet I doubt if it has been steadily adopted by many heavy land farmers where it was unknown before, so we must call the witnesses once more into court. Mr. Baker, of Writtle,* no mean authority, says that it prevails in the Roothings of Essex; that it renders the land for several years more easy to pulverize, improves the first grain-crop 20 to 25 per cent.; that the barley is of a better quality by 2*s.* a quarter; that it costs 40*s.* per acre, and that there is no manure so cheap at the price. Mr. Eli Turvill† says, that in the Roothings the first crop pays for it, while the land is much better for the following crops; that it is repeated every four or six years. Mr. Litchfield Tabrum‡ began the practice in the Roothings in 1823, spent on his farm a large annual sum in this manner, yet found it answer, and knows that it improves land by 25 per cent. Leaving Essex, we find Mr. Peirson§ saying that clay-burning is now very extensively practised in Suffolk, and that his Farmers' Club reported strongly in its favour. Mr. Raynbird|| says that the practice of burning the soil dug from the corners of fields is very general in the heavy land of Suffolk. This is called "border-burning." There is another system of ploughing, harrowing, and then burning with the help of thorns or furze, the whole surface of the field. This is called "clod-burning." In Cambridgeshire, and again in Bedfordshire, Mr.

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* On the Farming of Essex.—Journal, v. 13.

† Eli Turvill on Burning Clay.—Journal, iv. 267.

‡ Litchfield Tabrum on Burning Clay.—Journal, iv. 268. See also Mechi on Burning Clay.—vii. 297.

§ Peirson on Burning Land for Manure.—Journal, viii. 77.

|| Report on Farming of Suffolk.—Journal, viii. 317.

Pym * practised border-burning for seventeen years on heavy land (which I have myself seen), and increased his produce of wheat nearly 10 bushels an acre. Another witness, having heard at a Bedfordshire meeting farmers declare "that they could not cultivate to any profit their strongest and worst lands without clay-burning," used it in Leicestershire, where it answered so well that his neighbours adopted it too. He says:—

"A neighbouring farmer tells me that a field he dressed in this way *seven* years ago has *ploughed easier by a horse-draught*, and has been *like different land ever since;* whereas lime, especially if very caustic, makes the land closer and colder than ever." †

Yet I know a case where lime has just been vainly applied at a great outlay to an entire strong clay farm taken in hand, and burnt clay has not. So slowly spreads agricultural knowledge. The most striking account, however, is Mr. Randall's ‡ of his poor clay farm in Worcestershire. He tells us of a field called Roughhill, valued at 7*s*. 6*d*. an acre. This he clod-burned at a cost of 42*s*.; and after vetches fed off, got 45 bushels an acre of wheat, which sold, at 7*s*. 5*d*. per bushel, for more than the fee-simple of the land; and he gives many more cases which a clay land farmer will do well to read. He tried the ashes as manure against sheep folding, and found them equal; and I have myself found them so likewise. They not only open the land, but manure§ it as well. The cause, no doubt, lies in Dr. Daubeny's distinction between the available and unavailable parts of the soil, and the unavailable parts must be decomposed by the fire. Still the mode of action is uncertain, and chemists would do well to examine it; the result is certain on most soils, and, as farmers, meanwhile we may practise without quite understanding it. Often, however, instead of making heavy land light, we want to make light land heavy, which must be done by marling or claying.

§ 5. *Marling or Claying.*

I need not describe the effect of marling a blowing sand. The finest example I have seen is on the Duke of Bedford's home-farm at Woburn, where in consequence the old parish turbary is waving with corn. The glories of Holkham, too, once a sandy waste, rest on this foundation of clay. The Lincolnshire plan, also, of digging deep trenches in peat, and throwing up the clay on the surface, has been often described; but it will not be amiss to give the following figures by a fen-farmer, because people are scarcely aware how *cheap* are our standard modes

* On Burnt Clay as a Manure, by F. Pym.—Journal, iii. 323.

† Journal, iii. 324. ‡ Journal, v. 113.

§ In Somersetshire, a farmer, near Bridgewater, having some patches on his land where the crop always failed, burned the clay, and cured the evil. He has since used burnt clay regularly on his farm.

of improvement, and how immediate is the return. The cost of thus claying* in 1841 was put at 54*s.* The effect is stated as follows :—

Yrs.	Produce old state.	£.	s.	d.	Produce after Claying.	£.	s.	d.	Profit in 3 Years. £.	s.	d.
1st.	5 qrs. light oats, 20*s.* .	5	0	0	6 qrs. oats, 21*s.*. . .	7	4	0			
2nd.	Seeds (4 sheep per acre)	1	4	0	Seeds (7 sheep per acre)	2	2	0			
3rd.	20 bshls. very light seed wheat, 50*s.*	6	5	0	30 bshls. wheat, 60*s.*	10	17	6			
		£12	9	0		£20	3	6	£7	13	6

The outlay is 54*s.*, the yearly return 51*s.*, or about 95 per cent. profit. The figures indeed of the produce would now be lower, but *the difference must be the same.* There is a great deal of land in the wide eastern fens which may still be so treated. The mosses of Lancashire are more difficult, being poorer, softer, and deeper, like the Irish bogs ; but they, too, are beginning to yield. Mr. Wilson Ffrance has reclaimed 700 acres of this barren waste. The expense has been greater, because the marl has been led upon a railway, but it has paid well,† and the potatoes are worth 20*l.* an acre, being exempt from disease on the peat. In another corner of England, Somersetshire,‡ a different course is pursued ; there peat finds a sale as fuel. The peat is sold to purchasers, who pay for it 20*l.* per acre as it stands in the ground, cutting and removing it, as well as levelling the ground afterwards at their own expense. The peat is being dug away to a depth, perhaps, of 15 feet, and the river floods gradually deposit silt on the bottom ; a very cheap, or rather, profitable process, certainly, producing excellent land into the bargain, which lets at 40*s.* an acre. There is yet another mode of improving moory land—

§ 6. *Lime.*

I do not speak of lime as an ordinary manure, in which character it is considered indispensable on the west side of England, and is generally found utterly useless elsewhere. Whether this difference arise from soil or climate, I know not ; but I believe lime to answer best in rainy climates on wet soil of primitive strata. In western districts when land is first brought into use from waste, a heavy dressing of lime is a sine quâ non, and hence the discovery of a limestone rock is a public benefit. Lime, too, there has a peculiar effect in sweetening and strengthening grass. As an example is always useful, I may cite again

* Journal, ii. 406.

† Consult an interesting account of Mr. Ffrance's operations in Mr. Garnett's Report on Lancashire.—Journal, x. 25.

‡ See Report on Somersetshire in the present Number.

Mr. Blake's improvements on Brendon-hill in Somersetshire, inspected by me many years since, and now described by Mr. Acland.* It is as sour, bleak, and backward a country as can be visited. Mr. Blake, after draining, dressed at once with 100 bushels of lime per acre, and laid the whole down to permanent grass; giving it afterwards 50 bushels of lime every three years, and letting it by auction as summer pasture to low-country graziers. The increased value is as follows:—

	Acres.	Rent 1802.	Valuation 1832.	Let 1849.
		£.	£.	£.
Venne Farm	233	100	115	
Out of which	166	..	..	365
Cooksley Farm . . .	129	..	45	
Out of which	95	..	..	176

The improved letting included tithe and taxes, and there is a further deduction of 12*s.* 6*d.* to be made for 50 bushels of lime per acre every third year; but the practical success, as I have myself seen, has been long complete. The wisdom of Mr. Blake has consisted in the adaptation of means to his circumstances, and he has given an excellent example for his Welsh neighbours to work by. The profit is certainly very large. In Cheshire we find a very distinct but equally effective mode of improving grass land:—

§ 7. *Boning Pastures.*

This Cheshire practice consists in applying an extraordinary dose of bones to pasture land. "For pasture land, especially the poorer kind," says Mr. Palin,† "there is nothing equal to bone-manure, either as regards the permanency of its effects, or the production of a sweet luxurious herbage, of which all cattle are fond. Many thousand acres of the poor clay soils have been covered with this manure during the last eight or ten years." The average quantity used is about a ton and a half to the acre; it is therefore a landlord's improvement, on which 7 or 8 per cent. is generally paid. Boiled bones act as long as unboiled bones, retaining the phosphorus, though not so quickly, having lost the animal matter. Boiled bones (1845) cost 3*l.* 10*s.* per ton; the outlay then was 5 guineas per acre, sometimes 7*l.* or 8*l.* "I have known," says a correspondent, "many instances where the annual value of our poorest clay-lands has been increased by an outlay of from 7*l.* to 8*l.* an acre, at least 300 per cent.: or, in other words, that the land has been much cheaper after this outlay at 30*s.* than in its native state at 10*s.* per acre; with the

* Report on Somerset, near the beginning.

† Report on Cheshire, vol. v. p. 89.

satisfaction of seeing a miserable covering of pink-grass, rushes, hen-gorse, and other noxious weeds exchanged for a most luxuriant herbage of wild clover, trefoil, and other succulent grasses." Though much of the clover and trefoil may disappear in five or ten years (sometimes they last fifteen years), an excellent herbage remains. Draining, the writer adds, "*may be carried too far* where bones are used, for boned lands suffer by a dry summer. The land should be kept cool."* I have found the same thing on water-meadows. The freer the grass is growing, the more it suffers from drought; and this is natural, for a larger supply of sap is required. This writer adds, "*I have known many a poor, honest, but half-broken man raised from poverty to comparative independence, and many a sinking family saved from inevitable ruin, by the help of this wonderful manure.*" Indeed, I believe land, after boning, will keep three cows where two fed before. As to this practice, however, caution is necessary. It seems to belong to cold clays for grass in Cheshire, though on such soil it would hardly answer elsewhere, even for turnips. A Cheshire landlord told me that he had tried it vainly for grass in Suffolk. I know no case of its success out of Cheshire, unless in the bordering counties, and have heard some cases of its failure even in those. It will not do, therefore, at all to adopt it hastily. We only know it to have succeeded about Cheshire, which is on the red marls geologically, and on the rainy side of the country, and must remember that it is a costly proceeding, striking in its success, but as yet circumscribed in its practice, and therefore in the proof of its efficacy.

§ 8. *Chalking.*

The process of chalking, on the other hand, is a very wide and a very cheap one, for it costs under 3*l.* per acre, and is as old perhaps as the Heptarchy. I have seen the chalk carried by donkeys over the fields in Dorsetshire; wound up by shafts from small mines, and wheel-barrowed in Hampshire; worked from a quarry and carted on the Lincolnshire hills which overlook the Humber. Yet on the other side of the Humber, on the Yorkshire wolds, this cheap improvement is neglected by the farmers, though it lies under their feet, and in riding the length of the Southdowns you may see much land that wants it. No one doubts its efficacy if the chalk be of the right kind. I believe, old as is the practice, that residents on southern chalk-hills would find few farms where some field at least, or some rough ground, does not want it, and certainly there is no lack of hands ready to spread it. Sometimes, indeed, you may plough up the

* Report on Cheshire, vol. v. p. 94.

chalk if it be soft enough, and so save all hand-work and carriage. I have seen this succeed on the Surrey hills.

§ 9. *Irrigation.*

The formation and use of catch-meadows have been lately described in this Journal.* They cost about 3*l.* an acre to form, while farmers say that they double the produce; and their formation may, therefore, reasonably be set down as yielding a profit of from 30 to 50 per cent. No other agricultural investment can be compared with them for profit and convenience. They belong specially to the western or rainy sides of Great Britain and of Ireland, where the mild winters favour the growth of grass, and they are at home on the mountain sides which rise on those coasts. But though born on the glen-side they have spread over the flats, and I have found them invaluable on the dry side of England for summer use also during long drought. Sometimes, too, gutters may be cut very cheaply, say for 1*l.* an acre, to distribute the occasional floods of rivers—an improvement which may be equal to a dressing of dung. Summer irrigation has a tendency in some places to rot sheep, but it has not done so yet here, and the water is laid during summer on the Duke of Portland's famous meadows at Clipstone. I have obtained from a friend for the present Journal an account of the water-meadows in Switzerland. There, as here, the growth of watercresses and excellence of the fish are the proofs of water fit for this purpose. But they have a third proof—the power of dissolving soap. This sets at rest the question whether water *must* be hard for irrigation; since every washerwoman knows that hard water contains lime, and curdles her soap. The peculiar softness of feel as a test of good water leads me to believe in a new cause of its mysterious action, not exclusive of the old causes, but additional to them, for *winter* irrigation is a *complex* phenomenon. In speaking of ammonia brought from the air by rain, Liebig says,†

> "The sensation produced upon moistening the hand with rain-water, so different from that produced by pure distilled water, and to which the term *softness* is vulgarly applied, is also due to the carbonate of ammonia contained in the former."

He further tells us that Hünefeld has proved all the springs in Greifswalde and three other places to contain carbonate and nitrite of ammonia. It appears to me a legitimate inference that our own soft and warm springs issuing from the depths of the earth, fertilize our meadows by bringing with them ammonia, the result perhaps partly of ancient volcanic action, partly acquired by filtration through the upper soil, for in soil too, even unculti-

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* On Catch-Meadows, Journal, x. 462.

† Liebig's Agricultural Chemistry, 4th edit. p. 46.

vated soil, modern chemistry has recently detected ammonia, so that this hidden spirit of vegetable life not only hovers over us in the air, but also broods in the earth, and gushes forth with the fountain. My own meadows are managed in a new manner by repeated pennings with sheep, and, on a farm of about 460 acres, I keep a thousand breeding ewes, some of which are now fatter than necessary, being almost fit for the butcher. Nothing in fact pays better than growing grass, or worse than sour pasture.

§ 10. *Breaking up Grass-land.*

Although the present price of corn, therefore, is not encouraging, occupiers still look on it as a boon to be allowed to break poor grass land. No doubt, if worked in a four-field course, it will keep as much stock in the two years of green crop as it before would in four; so that you get the corn for the cultivation, which on some such land may be very light. Take a light moory land, for instance, which here, at least, cannot be ploughed too little. Pare it with the breast-plough, burn, sow rapeseed, and pare again to cover the seed. This may cost 28*s.*; for which, if the ground be cool, you may get a crop of rape that will hide the sheep as they eat it. Next year pare again with the breast-plough, which may this time cost 8*s.*, and sow oats, with rye-grass, that may remain for two years. Two hundred acres of such land were cultivated in Gloucestershire in this way by a family of good farmers for a long course of years, without feeling the plough more than once in four years. The crops are good, and the whole expense of such cultivation is insignificant. But there are so many kinds of poor grass-land to be broken up, that it would be unwise to lay down fixed rules for doing it. Certainly, however, where the land is pretty fair, you may take some liberties with it at the beginning, and grow two white crops together; but it is thought best generally to begin with a green crop for fear of the wireworm.

§ 11. *Improvement of Farm-buildings.*

There is no doubt that our farm-buildings are grossly deficient in many counties, and it is unluckily equally certain that to build them anew exceeds the means of most landlords; but to build cattle-sheds for those which exist, or set up a new field-barn and yard at the farther end of a farm, may often be done very cheaply by help of a stone quarry and plantations on the estate. The farm-house, too, should be made a comfortable residence. A farmer with a family is not merely a farmer, and a superior farm-house is good for his landlord as well as himself. The farmer's habits and situation are so much raised that the farm-house may well resemble the parsonage. But besides the difficulty of finding

money to raise an entirely new farmstead, a man with 3,000*l.* set apart for the purpose, might well be uncertain what plan to adopt. Notwithstanding the really excellent plans of farm-buildings we have recently published, for one I certainly should be puzzled; because farm-steadings, like certain countries, are really in a state of revolution. Our old ideas about them are unsettled, our new ones undetermined. Their form must depend on the management of stock, and the management of stock partly on the management of manure, which last is become the most intricate of all points in husbandry. Manure, however, belongs to the practice of farming. We may here close, then, the list of improvements which it is in the landlord's power to effect. We must add, indeed—

§ 12. *Warping.*

But though an admirable operation, still, as it is confined to two rivers, the Ouse and the Trent, it is not of general practical interest, and having been often described in this Journal, will not require our attention. Landlords' improvements stand then under the following heads:—

1. Draining	1. Trunk draining. 2. Under draining.
2. Removing	1. Fences. 2. Trees.
3. Game.	
4. Burning Clay	1. Border-burning. 2. Clod-burning.
5. Claying	1. Sands. 2. Peat.
6. Liming Grass-land.	
7. Boning Grass-land.	
8. Chalking.	
9. Catch-meadows	1. Hill-side. 2. Flat. 3. Flood.
10. Breaking up Pasture.	
11. Farm Buildings.	
12. Warping.	

Our means of improvement are certainly manifold. I have been anxious to prove them so in these times of difficulty, because in agriculture, as in medicine, there is a tendency to dwell exclusively on some particular remedy. The quack, indeed, has of course only one nostrum; but even regular physicians have a leaning sometimes to favourite drugs. Variety of treatment, however, is the true test of ripe art. They are not arrayed as if English landlords were slow in adopting admitted improvements upon their properties, for such is certainly not the case now; but landlords do require that the variety of their resources be brought under their eye: they will find in almost all these practices

the additional merit, which I know by experience to be great, that while they improve the land, they relieve the tenant from the necessity of finding employment for labourers in the winter—a time when farmers can often hardly find work to give.

Management of Manure.

The construction of farm-buildings, as I have already said, must depend on the proposed management of the manure. But this is a doubtful question, even in practical farming; and chemistry can as yet say little about it, because we have few analyses of the droppings or urine as they proceed from the animal, and if we seek to trace the changes which these afterwards undergo, we find, unfortunately, that Boussingault's analyses of prepared dung, on which we might have hoped to reason, are pronounced by Liebig* to be chemically incorrect. Walking then thus in the dark, it behoves us to be wary in following lights that would divert us from the beaten track. Our practice hitherto has been to make the dung in open farmyards, but to this practice two objections are raised, the escape of ammonia into the air, and of liquor into the neighbouring ditch. For these two defects then various remedies have been proposed, one of them the use of liquid manure. Sometimes a drain is made from the cowhouse, conveying the urine into a tank from which it is carted, and so distributed over the land. One farmer I see thus distributed the urine of thirty beasts unmixed in the last spring, having kept it throughout the winter. I feel bound to point out the heavy loss he has thus incurred. According to Sprengel the contents of a cow's urine stand as follows:—

Water	92,624½
Urea	4,000
Free ammonia	205
Other matters	3,171
	100,000

The urea is the matter from which is formed by fermentation the ammonia which we seek to detain, and Sprengel desiring to ascertain how far water would serve the purpose, left one portion of the same urine pure and another portion mixed with an equal quantity of water; both to stand for a month. The result was as follows:—

Pure Urine.		Mixed Urine, omitting the water added.	
Water	95,442	Water	93,481
Urea	1,000	Urea	600
Ammonia, partly uncombined	487	Ammonia	1,622
Other matters	3,071	Other matters	4,297
	100,000		100,000

* Liebig's Agricult. Chemistry, 3rd Edit. p. 209.

"The addition of water," Sprengel remarks, "has this advantage, that the diluted liquid contains nearly four times" (more than three times) "as much ammonia as urine left to putrefy in its natural state, though it retained only 0·4 less of urea."* He supposes that a cow produces 15,000 lbs. of urine yearly, and that by leaving pure urine in a tank we should thus lose 162 lbs. of ammonia, which, at Mr. Way's estimate of 6*d.* per lb., would be a yearly loss of four pounds sterling per cow; and this, too, as compared with the mixed urine.

The loss of ammonia on the mixed urine is severe, amounting in fact to one-fifth. Well may Sprengel say, "Whoever is obliged for want of straw to collect the urine separately, whoever, if compelled to do this, mixes no water with it, or fails also to employ some neutralizing substance to combine with the ammonia, suffers a loss of manure which exceeds all belief." I can nowhere find how much water is necessary to save all the ammonia. If much, the labour of application is greatly increased; but however much water be used, when we consider how slightly even a heavy shower of rain penetrates dry ground, I cannot but think that much of the ammonia after it has been delivered from the cart must be liable to escape. Besides, if the urine be collected separately upon system, what is to be done with the straw? It cannot be used separately as dry manure. Are we to cut it all up into chaff as food for stock? I do this largely myself, but it may be done, I think, too largely. There is reason to think, as we have seen, that the good effect of straw in supplying carbon as the substance of crops has been too much overlooked lately. Now it is clear that a large part of the straw eaten by stock is literally *consumed* by them, and is dissipated like smoke through their nostrils in their breath. According to Block, a sheep fed on 100 lbs. of rye-straw with water voids only 40 lbs. of excrements *solid and fluid,* so that more than half the carbon is wasted. The same thing, in fact, happens as in the obsolete Lincolnshire practice of threshing the wheat and burning the straw afterwards in the fields. If our stock eat the straw from 100 acres, we have in fact burnt the produce of 60 acres. It is an excellent practice to give chaff as food; yet if all the manure be applied as proposed in a liquid form, we might burn too much straw. But there is another of the three great manuring substances, namely, phosphorus, about which we have to inquire in judging the propriety of employing liquid manure; and when one sees it stated broadly that modern science has decided in favour of liquid manure—when one reads, too, that in a Scotch county iron pipes are laid down over a farm of nearly 400 acres,

* Sprengel on Animal Manures. See translation, Journal, i. 455.

at a cost of towards 2*l.* per acre, in order to distribute the urine of 150 cattle by hose over the entire surface,—however much one must respect enterprise and ingenuity, it becomes imperative to examine the philosophy of the arrangement. Now, it actually appears by the analyses of Boussingault and of Von Bibra,* that the urine of the ox and the horse contain none of the phosphorus voided by them, which remains exclusively in their solid droppings. The arrangement, then, really seems opposed to theory as well as to practice, since an expensive and troublesome apparatus is laid down which not only leaves behind carbon, about which some doubt may exist, but actually forgets another element — phosphorus, known positively to be essential for a principal crop, that of turnips. It may be possible to amend the plan by mixing the solid droppings with the urine, and force both united through those pipes. It may be possible, I say, to force this pulpy fluid through a long range of pipes without clogging them, though I much doubt it. But even then, I ask, what is to become of the straw? Are we prepared to forego all use of it upon the land; and if not, in what form is it to be applied? When the capital of landlords is so much wanted for undoubted improvements, it becomes a bounden though ungracious task to warn them against what appears to the last degree questionable in science as well as novel in practice. We indeed have little or no experience on the subject; but foreign writers who are best acquainted with liquid manure, seem least enamoured with it. We have heard Sprengel, a German and a chemist, who says again, speaking of its German use as mixed largely with water, "The urine tanks are not such excellent arrangements as they are frequently represented to be, and it is in many cases more profitable to pour the urine over the dung in the dung-pit, or to supply so much straw that the whole of the urine may be absorbed." What says our other great authority, Boussingault, a French chemist and farmer? "He is led to adopt the opinion of Mr. Creed respecting them, viz., that the advantages ascribed to them in Switzerland are exaggerated." Lord Spencer, I know, had strong objections to the housing of cattle, except of course the fatting beasts. When he first began farming, as he told me, it was the fashion for every gentleman who piqued himself on his farming, to soil his cattle; but he had seen the fashion expire. Sir John Sinclair visited a field of a Mr. Harley's, manured by an engine with cow-house drainage, which had been mown sixteen times in three years." This statement is, I suppose, forty years old, yet one would think it had been written yesterday.

This marvellous effect of liquid manure is not indeed due

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* Liebig's Agricultural Chemistry, 4th edition, p. 269.

simply to the use of the liquid. The mere mowing would give more grass, because the feet of animals trampling at liberty while they feed at will, checks the growth of the young grass, and this I believe to be the principal reason why folding of sheep, as already mentioned, should afford so much more keep than allowing them to range at large. The system seems specially suited for cows kept to supply large towns with milk, but even if the use of liquid manure were desirable as a general practice, it seems scarcely suited to the health of young animals. Foreign writers always ascribe its adoption to scarcity of litter. In Switzerland, where it has been longest in use, the straw litter of the cattle is twice a-week withdrawn from their beds, washed, and replaced; but such a scarcity of straw is certainly not the grievance under which our arable farmers labour.

It has also been proposed as a remedy against the escape of liquor to roof over the farmyard. But the straw lying loose would be apt, I think, to get fire-fanged, as is now the case with horse litter thrown too thickly into the yard during dry weather. In this part of England the dung does not get made even in the open yard when our usual scanty allowance of rain at all fails. A roof for the dung-heap has been further also suggested. This may perhaps be required in Lancashire, but I would not venture it here.

Seeing, then, the lack of a remedy, it may be worth while to inquire into the extent of the disorder; and, first, as to the escape of ammonia. The two remedies which Boussingault, *as a chemist*, proposes, are the exclusion of air and moisture. "The daily addition of fresh litter from the stables," he says, speaking, indeed, of the dunghill, but the principle applies equally to the yard, "powerfully impedes the escape of the volatile elements, protecting the inferior layers from the direct contact of air." The German Thaer, indeed, examined chemically the air collected from the surface of dung-heaps, and found little or no escape either of carbon or of ammonia. Pressure our farmers provide by the trampling of beasts in the yard, and by driving their carts over the dunghills. With plenty of litter there need be no smell, even in a yard where eighty hogs are being fatted at once, as I have often experienced, but the pleasant scent of fresh wheat-straw. Dry hot weather is the time when most waste occurs; and then it would be well, certainly, to screw a hose on the pump, and distribute water over the yard: for though chemists differ as to the changes which farmyard dung undergoes, all agree as to the utility of water in diminishing the volatility of the ammonia. They agree that the urea, in the first place, is a fixed salt, and that it becomes volatile as ammonia, but in what mode they do not agree. They also agree, which is important, that in well-

made dung more or less of this volatile ammonia is, in some unknown way, brought again into a fixed state. Sprengel thinks this is brought about by humic acid, arising from the decomposition of straw. Liebig denies the existence of such an acid, but says that decayed woody fibre has the power of absorbing ammonia to seven hundred times its own bulk.

Much ammonia, it seems likely, must be fixed in some way, because in dunghills which are ripe, and yet not decayed, one perceives little or no pungency of scent, while practice shows that such dung has not lost its vigour. There is danger then, that after all in applying the liquid portion apart, we may dissipate the very essence we are seeking to save, which would otherwise have been fixed by a natural process. Supposing, however, that we adhere to the old practice of making dung in farm-yards with the help of the rain from heaven, there remains the objection that the supply is sometimes in excess, and that a black stream runs away into some neighbouring ditch. This picture, a very common one, is, I think, somewhat overdrawn; or rather, is sketched from dairy farms, where litter is scarce. On arable farms I doubt if the waste be very great. Much will depend, of course, on the average amount of rain, which varies, as we have seen, in different counties. I have no experience on the matter, because my own yards have their vent upon catch-meadows, over which the waste fluid is dispersed by the stream that runs through each yard; but Mr. Thompson's plan of a tank, as improved by Mr. Hannam,* seems perfect. The farm-yard should be hollow in one part, and drains from the stables may empty into this part. Here straw may accumulate, and be steeped in the muckwater. To prevent its overflow, a drain should be led from the upper level of this hollow to a tank out of the yard, and by the side or in the centre of a paved hollow like a shallow gravel pit. When the yard is cleared the dung can be deposited in this pit, and the liquid from the tank be pumped over it as occasion requires. I should add a well in case of dry weather, when the liquid in the tank might not suffice to keep the heat moist without the use of plain water. "Plain water," says Mr. Thompson, "has been found to answer exceedingly well." When the manure is to remain long in the pit, it is covered with soil, and both moisture and gas are so completely retained, that nine people in ten might walk unconsciously over it.

A still simpler plan, I think, would be the following. Let the straw-yard be shaped hollow to the centre, like a shallow dish. In the centre might be the tank, surrounded by a low wall, and from thence, with a pump and hose, you might easily return

* See Mr. Hannam's account, reprinted at the end of this paper, from the Journal of Yorkshire Agricultural Society, 1843.

the fluid drainings upon the straw. If perfection be sought in fixing ammonia, a little sulphuric acid might be poured into the tank. If there be occasion to lead manure straight from the yard to a heap in the field, I strongly recommend a foundation of road-dirt or earth, which will absorb the escaping fluids, and serve excellently afterwards to be drilled with artificial manures.

Some farmers are trying the cutting up of their litter, so as to apply the manure at once to the land. The difficulty which I see is in always finding land ready to receive manure. The manure is applied of course unfermented. Now, so far as we know, manure must be fermented, that is, the urea must become ammonia, before it can become the food of plants. Still this forms no objection, because the transformation doubtless will take place under ground. The box-feeding system seems to have been firmly established by Mr. Warnes for *fatting* beasts. The box, about nine feet square, is sunk two feet in the ground, and is itself the tank in which the animal rises upon his own litter, until his head touches the ceiling. Here the principle of pressure is relied upon singly for retaining ammonia. Care is requisite in supplying the litter, for if given too freely, it heats; if not frequently enough, the air is tainted. So, on a large scale in Lincolnshire, the folding gates between yards are hung a yard high from the ground, and the straw accumulating is trodden down in the open yard by young cattle.

Whether sheep dung should be made artificially, under sheds upon boards, seems to me a doubtful matter. I have left off shedding my own sheep, having found that of two weighed lots the shedded lot did rather the best in January, and the folded lot in March. The sheep certainly has a good great coat provided by nature, which, moreover, cannot be curried in confinement like the hide of a cow. My shepherd says that the sheep fat fastest in clear frosty weather, because they eat more; and this is quite reconcilable with theory, if animals find fat ready made in their food as they do muscle, because, while taking in more fuel, they would take in more fat. It would be like an express-train, which uses more coals, but goes faster. On the other hand, I know as a certain fact that sheep which have been kept very warm in sheds upon boards, have eaten certainly very little, but have also been exceedingly slow in laying on fat. But, as yet, theory is at fault on this matter. Wet weather is what throws sheep back, and then they must thrive best under cover, though the alternation cannot be well reconciled with the animal's health, so that we must decide one way or other, but which way seems to me as yet problematical. The balance seems to turn in favour of field-feeding on light land farms, yet there is some waste of manure in feeding off turnips upon the ground, if the crop

be a full one and artificial food be employed. Even if ploughed as close as possible up to the fold, the plough cannot come in until a whole length is cleared from end to end. Meanwhile, the loss of manure has been in great part incurred. Every farmer knows the pungent stench which proceeds, in dry weather, from a fold of high-fed sheep, but in a few days, before the land can be ploughed, this disappears, and with it ammonia has fled. Sheep-manure is, in fact, peculiarly liable to this waste; for the solid proceeds from sheep contain ammonia as well as the liquid, and both ferment immediately. The remedy lies in using the breast-plough to turn over a thin paring of soil by hand, as fast as the hurdles are shifted. It costs, perhaps, 5*s.* per acre; but this is no extra expense, because it saves the second ploughing, which is otherwise needed to mix the manure equally through the land: an essential point, I need not say, for the barley crop. I am determined in future to breast-plough when possible, even within the fold; for the health of the sheep sometimes suffers, though in the open air, from this intense escape of ammonia. Professor Way, I may mention, has illustrated this evil; for he has ascertained that the soil of my own farm has the hitherto unknown property, that when mixed with fresh urine it hastens the fermentation by two or three days, which clay on the other hand retards or prevents altogether. Many other soils, no doubt, have the same property; but once buried, the ammonia is of course safe, and this practice of following the fold with the breast-plough is found to answer in Oxfordshire and Gloucestershire, where it is used regularly by many farmers.

On the management of manure generally, it seems to me not that we should adhere rigidly to our present system, but that before this system undergoes a radical revolution, the various transformations of animal manure require to be traced by chemistry, with accurate investigation of its different stages, and that these results must be introduced into our practice, subject to the health of animals, and to the seasons at which manure is required. We are thus brought to actual cultivation. Before we consider, however, what a farmer *should* grow, the question arises, what he *may* grow according to the covenants of his lease.

Covenants.

It is generally felt that some change is required in the covenants which govern the rotation of crops; but though they are often discussed, I do not think the principle which ought to govern them is stated quite plainly. The agreements generally lay down what a tenant should grow. Under the usual, or four-course, rotation he is bound down to the well-known succession,— first, wheat; second, roots; third, barley; fourth, grasses, that

is clovers and rye-grass, called "seeds,"—and he is forbidden to sell hay or straw from the farm; nothing, by the bye, being said about selling roots. Now here is a fault one cannot but find. Under this agreement a farmer must not grow pease in the second year; yet a good farmer might be inclined to grow pease, followed by turnips in the same year. If he gave those pease to his sheep while eating the turnips, he could not do a better thing for his land than what this agreement forbids him to do. A bad farmer, on the other hand, having his land—very light land, perhaps—in rye-grass, might let a large portion stand for seed, thresh the seed, and take it to market. On such land he could not do a worse thing for the succeeding wheat crop; but the proceeding would be perfectly regular: so imperfect are our present agreements in both directions, for the good farmer and bad one. They look merely to what is *grown* on the farm, while the farm is impoverished only by what is *sold* from it. It is hard, too, to prevent a farmer from sowing spring wheat instead of barley. The justice of the case between landlord and tenant on light stock land, I speak of that only, would be met by the principle, that no vegetable produce should be sold off the farm, except white corn, and that no two white crops should be grown in succession. Whether this would be agreeable to tenants, I cannot tell, but for good farmers it would evidently be better than the present restrictions, and juster. Not that these terms are at all universally applicable. Good strong land is able to send beans largely to market, besides white corn; and in fact must do so, as it cannot support and does not require so much live stock as lighter land. Even the interval of a year between two white crops must suffer exception, since for some unknown reason, in many places, as parts of Sussex and of Lancashire, barley seems to answer best after wheat, and there consequently you must take two white crops and two green crops together. In South Wales, I find, by the most recent and comprehensive authority on the subject, Winsgrove Cook on 'Agricultural Tenancies,' the farmers do not like any conditions more stringent than this, "that they should not grow *more than four white crops* in succession." One hardly sees, indeed, how they *could*. Vain, however, as it may be to lay down any general rules, the principle of sale, rather than growth, though not to be rigidly enforced, clearly lies at the root of the matter, and therefore should not be lost sight of.

Foulness of Land.

We are now arrived at actual farming, and the first point is cleanness of farming. Much as we hear of foulness of land, I never met with any distinct statement of its evils or remedies. Common therefore as the subject itself may seem, it will be worth

while to clear up this matter. There are three distinct families of weeds: 1, annuals; 2, weeds with tap-roots; 3, weeds with creeping roots; and these three very different races require to be dealt with in entirely different ways. First, there are the annuals, more unsightly than mischievous, unless from extraordinary negligence. One of these, however, the charlock, has gained the mastery of a particular district, the South Down Hills. I remember it in 1804 covering the fields near Brighton with a yellow blaze, and filling the air with a sickly odour ; and still it may be seen along that range, sometimes even in June, overtopping the barley, the crop of which it must diminish by a quarter an acre. Its prevalence there arises from the growth of rape, unhoed, instead of turnips ; and the seeds, once ripened, being oily, may lie for years underground without injury, until they are once more brought to the surface. They should be removed by bringing fresh seeds to the surface, allowing these to shoot, and burying them again with successive ploughings and harrowings. Drilling the rape and hoeing would prevent their recurrence. But the yellow hue of the barley fields is not confined to Sussex, or due only to rape ; for Mr. Jonas, a practical farmer, in his excellent Report on Cambridgeshire, is put to the blush by the charlock in his own neighbourhood :—

"Here I must admit I am quite ashamed of my county ; for, notwithstanding its most excellent farming in many parts, we still continue to be disgusted in spring by whole fields of barley as yellow as saffron from the charlock in blossom ; whereas, by strict attention for a few years, never allowing a head to seed, they might be, as I have known them to be, completely eradicated."

Another gregarious annual with oily seeds, the wild flax, has been found equally injurious to barley near Cannock Chase. The corn marigold I have known a serious nuisance upon very superior sandy soil, and have seen it removed by a moderate dressing of lime. Chickweed almost stops cultivation on some fen-land in Somersetshire ; nor do I know a remedy, because, hoe it as you please, the slightest shower sets it again. Annuals, however, in general are easily dealt with : not so the tap-rooted plants, of which the dock is a sample, often to be seen upon slovenly farms proudly waving its banner over the harvest-field. These are anchored in the subsoil with a slender, carrot-shaped root, against which neither pulling nor ploughing avails, for though broken or cut, it shoots up again. The only remedy, as I know by experience, is to keep an old man at work for several winters digging them up with a paddle. Yet these root-weeds are again more ugly than mischievous. They strike a stranger, but the real injury and loss arise from what, if unacquainted with farming, he might mistake for harmless grass coming up in the wheat-

stubble. Every farmer will know that I mean couch-grass. This brings us to what I regard as the most important change required in south country farming, which it will therefore be worth while to consider minutely: I mean

Autumn Cleaning of Wheat Stubbles.

The peculiarity of couch-grass* lies in its long jointed roots, like the runners of strawberries; but these are underground runners, with joints at every inch, from each of which other small fibrous roots issue. The main roots may be a foot or two long, and, if

Fragment of underground Runner of Couch-grass. *Natural size.*

broken, each joint is as ready to grow again, as a potato-set with an eye in it. If the land be wet, you cannot get the couch out with the harrow; if you attempt to do so and fail, you break the couch, cut the runners, spread the joints, and thus increase, instead of diminishing, your untoward crop. The old fashion of naked summer fallows is still retained upon very strong clays on account of this weed, because the clods, when dry, are so hard that the couch will not come out, and they are therefore left to roast in the sun until they are dried through, and it perishes for want of moisture. On stock land in the four-course system this process of cleansing takes place between the growth of wheat and of turnips, and involves more labour than does the mere cultivation of the other three years together. The usual method has been to let the sheep range over the grassy stubbles in autumn, and give the land a winter ploughing towards Christmas. In dry, spring weather it is again ploughed to bring the couch uppermost, drag-harrowed with three or four horses to break the furrows, scarified with four or five horses to bring up the long roots, heavy rolled with three or four to squeeze the clods, light harrowed, light rolled again, light harrowed again, then all the hands turn out

* Besides the true couch, *Triticum repens*, there are three species of quitch, or *Agrostis*, equally troublesome as having creeping roots, and regarded practically as the same with couch.

with rakes to gather this unravelled network, heap it, and burn it. But if the ground be really foul you have not done yet. After a few days you see fresh blades of grass shooting up over the bare ground, and find the enemy still left behind, so that the ploughing, harrowing, rolling, raking, and burning must begin over again—very likely be repeated a third time. All this I have done, and done for the last time. Every farmer knows the process well. Sometimes it interferes with the barley sowing —a critical matter; sometimes the barley sowing interferes with it; sometimes the weather is wet, and it cannot be done; often there is a long drought, and the ground is rendered so dusty that it never again becomes moist enough as a seed-bed for turnips. All these well-known disadvantages are in attendance. But to prove the absolute expense, I will extract from a standard work, 'Bayldon, on the Art of valuing Rents and Tillages'*—his account of the bill to be paid, under a change of tenancy, for this operation; and his charge is estimated, be it observed, not for a field casually foul, but as a regular ingredient of the cost of the entire turnip crop of a farm every year:—

Turnips.

	Per Acre. £.	s.	d.
First ploughing at Christmas, at the rate of $\frac{3}{4}$ of an acre a day	0	10	0
Second ploughing in the spring, at 1 acre per day	0	8	0
Four times of harrowing	0	4	0
Rolling once	0	1	0
Gathering and burning couch	0	1	6
Third ploughing	0	7	0
Three harrowings	0	3	0
Rolling	0	1	0
Two harrowings	0	2	0
Couching	0	1	0
Fourth ploughing	0	7	0
Harrowing and rolling	0	3	0
Couching, &c., last time	0	1	0
	£2	9	6

On a farm of 200 acres 125*l.* every turnip season. Now let us hear from Mr. Raynbird what is done by Suffolk farmers. Immediately after harvest the land is broken up with the skim-plough (upwards of 1½ acre may be thus ploughed in a day); heavy harrows are used to pull the land a little to pieces; the

* Bayldon's 'Tillages,' 6th ed., p. 81.

roller to break the clods: the light harrows for collecting the rubbish to be burnt or carried off. The scarifier and harrows go over the ground once more, any straggling pieces of couch-grass are picked up by women and children, and the work is done.* This is a great saving; but another Suffolk farmer, to whose statement I called attention three years ago, goes further yet, a great deal. Mr. Bond says: †—

"In this district the labour of making fallows has within the last few years been greatly diminished by the practice of *forking out the couch grass* before ploughing the wheat-stubbles. By far the greater portion need only be ploughed *once*, as a preparation for the root-crop. Women and children are employed to look over the wheat-stubbles directly after harvest (accompanied by a man to see the work carefully performed) to take out couch-grass and docks. This, on a well-cultivated farm, *from being made a system of*, is quickly and cheaply done."

Cheaply, indeed, according to the Report on Somersetshire,‡ in which Mr. Acland says:—

"I saw a field of Mr. Hudson's at Castleacre, in Norfolk, so cleaned at a cost not exceeding 1*s*. an acre, and had great pleasure, on returning home, to find that two friends and neighbours had long practised something of the same sort. I mentioned the practice to a very good farmer near Sherborne, and was told the thing was *impossible* without a ploughing first."

Impossible, no doubt, if the land be foul; but if the land be well cleaned and *kept* clean (perhaps at first by missing a clover crop), not possible only, but certain. There may be more difficulty in the north, where the harvest is later; but even there, though you may not be able to autumn-clean, if you once clean thoroughly, you certainly may fork on the stubbles, which, at Mr. Hudson's, costs only *one shilling* an acre. As Mr. Bond says that roots may be thus sown on a single ploughing, we may leave 8*s*. more, as enough for that ploughing, and strike out at once the remainder of Mr. Bayldon's long bill, which will give a saving of 2*l*. an acre upon the turnip-crop, that is, on one quarter of an arable farm—*ten shillings* an acre therefore saved upon the whole farm, and as 1*l*. is the average rent of land in England, a saving of one-half the rent. Let no one hereafter speak of clean farming as expensive farming. What high farming may be remains to be seen. At all events, according to Mr. Bayldon, we have saved *two pounds* per acre to pay for artificial manure on our turnip-crop, which we must hope will suffice.

It may be said, I know, that a saving of horse-work at a particular time is not money saved, and this would be true enough; but it so happens that by other means we have saved horse-work at

* For further particulars see Raynbird on 'Suffolk Farming,' Journal, vol. viii. p. 287.

† Pusey on 'Autumn Cleaning,' Journal, vol. viii. p. 570.

‡ In the present Number.

all times. In ploughing all the year round, by reducing 3 horses to 2, and by using scarifiers, &c. instead of ploughing at all; in summer, at harvest, we have seen that 5 horses in carts can do the work of 10 horses in waggons; the same will be nearly true about dung-carts, and here we save horses altogether, at the sorest pinch of all in the spring, when before we wanted to do two things at once, clean our land and sow our barley. I know these things, for I practise them. I had a farm full of couch, and having now made it clean, keep only 9 horses, with an occasional ox-team, on 460 acres, and do not expect to want the oxen in future. Autumn cleaning, however, does more than dispense with Mr. Bayldon's long bill, which I hope may be read as a curiosity in after years; it brings on

Winter Cropping.

In the south of England we have a very long gap indeed, between the wheat-crop and the following crop, the turnip. We begin to reap sometimes in July, we clear the fields in August, and we cannot sow our swedes before June for fear of the mildew, while our turnips are not got in till July, so the land is idle for the best part of an entire year, except that the stubbles, if couchy, feed a few sheep and harbour partridges, whilst the winter fallow affords a sheltered seat for the hare. This is, in fact, unavoidable while the land is full of couch, but root it out, and the gap is filled up at once; so that here is another great saving, since you obtain five crops instead of four for four years' rent. "Rye," says Mr. Bond, "is largely sown, coming soonest to feed. Rye is indispensable to the flockmaster. The land ploughs up after rye in a friable state; beet and turnips are grown quite equal to those on land made a fallow of and worked about in a regular way." The St. John's-day rye is one good variety. Mr. Baker, of Writtle, grows another excellent kind. He recommends that the ground should be harrowed fine, and the rye sown shallow. He cuts it into chaff for horses and cattle, but it is also excellent for sheep; and the more valuable, because coming in April it enables you to finish your swedes at that time, and every farmer knows that to keep the flock on swedes till May is the sure way of spoiling a barley crop. It ought to have 3 cwt. of guano sown with it, which will double or treble the crop; and as Mr. Baker values his crop at 8*l.*,* if we set it now only at 4*l.*, the 30*s.* will be amply repaid. Rye being sown in September and October to feed off after turnips, we next, of course, sow winter vetches, drilled with guano to follow the rye. Every one knows there is nothing better to feed weaning lambs with. In fact these matters

* Consult Mr. Baker on 'Rye as Green Fodder,' Journal, vol. vi. p. 181.

are so well known to good farmers that I am almost ashamed of describing them; still I wish them to be not only common, but universal, that is on soil suited to them. Swedes will be sown in good time after the rye, and turnips after the vetches.

Besides these two feeding-crops there is a grain-crop coming largely into use—winter beans. They are a great favourite in this neighbourhood, and are even substituted sometimes for the spring bean upon real bean land, as being less subject to the black aphis. They are often drilled in close double rows with a wide interval, in which root-crops are sown in the spring. mangold-wurzel, or turnips. Mr. Bravender thus describes the process on Lord Bathurst's farm at Cirencester:—

> "The beans were drilled in double rows, with an interval of 3 feet. In the spring the mangold was planted between the double rows in the centre of the wide space left. At harvest the wurzel was very regular, but not so large in bulb as those planted without beans; but on the beans being removed the wurzel grew very rapidly, and when removed for storing were *little inferior in weight to those where no beans had been planted.*"

The land, of course, was not so clean. Turnips also are sown in the same way, but are not equal to a regular crop, especially if the soil be liable to grow hard. My own plan is now to draw the beans, setting them up widely in rows, plough the land, and sow a fresh crop of turnips at once, which may be done by the middle of July, at the same time when other farmers are sowing their regular crop of turnips. There is another winter crop which I am trying this year, and which is as yet little known, if at all—I mean winter peas. They are grown about London, and have also been raised for some years by Mr. Brown, at Purton, in Wiltshire. They too will come off in time for sowing turnips; and Mr. Brown has had a good crop of turnips after them even this year. Thus we have two corn crops, beans and peas, which farmers will admit to be paying crops, and two fodder crops of rye and vetches, which certainly are paying crops when used for sheep; with which four crops we may surely occupy the land and fill up the three seasons which the wisdom of our ancestors set apart for the propagation and extirpation of couch. It is proved, then, that we may grow five crops instead of four in the four years for four years' rent. We may even do a little more. If the land be good and clean the wheat-stubbles can be scratched, and the mustard-seed broadcast before winter beans or peas; only it should be done at once, for mustard will not grow if sown late. There is another excellent plan followed by good farmers, whose wheat-land is clean, namely, to sow hop-clover on the young wheat in March. It may be penned off once by tegs after harvest (but not too close or too late), and in spring it will afford a crop of keep equal to winter vetches, in ample time to be ploughed up for the regular

turnip-crop. Again, on many or most soils you cannot get a good clover-crop every four years. There is nothing to prevent you from sowing rye after barley, and mangold-wurzel after the rye. Thus on a part of the farm the rotation might stand even thus:—

1st year.		Wheat, mustard.
2nd	,,	Winter beans, turnips, or vetches.
3rd	,,	Barley.
4th	,,	Rye, mangold.

This could be only on a part of the farm, but we certainly may obtain the fifth crop pretty generally; nor, as I said, will the beans injure the land if they are used on the farm; on the contrary, they will improve it, and the consumption of the several crops dovetails together. The same lambs, which have been placed with their mothers on the green rye, and when weaned been transferred to the vetches, will afterwards consume the peas and the beans in their troughs on the turnips and swedes, going off fat to Smithfield at about a year from their birth as mutton, but leaving their fleeces behind them.

Root Crops.

The culture of swedes differs absolutely in the north and the south of England. In the north they may be sown early in May; in the south you must wait another month, or the hot weather in August will give them the mildew. Hence in the south we cannot grow the crops of this root which are grown in the north. Thus the average prize-crops of swedes in Lancashire have been 40 tons per acre, while in the south we cannot get much beyond 20 tons. If we want to grow 30 tons of roots to the acre, it must be mangold wurzel; the culture of which is spreading, and would spread more but for its impatience of frost, and the farmer's dislike for the trouble of lifting, carting, and storing the crop in the autumn; in yielding to which dislike I yet believe they are wrong, for the orange globe mangold will grow on any light soil, and 200 tons of it are very convenient in May. In setting the seed I adopt Mr. Huxtable's plan so far that, after ploughing in dung, we dibble in by hand a pinch of manure under the seed.* Swedes and turnips, however, must be the mainstay; and with them not only a different season, but a different mode of culture, does and must prevail in the north and the south. For the north, the plan of setting them on ridges filled with manure is doubtless the best; but it is too slow a process for us in the south. Sowing in June, we wait for a shower to moisten the ground; then, with a drill 6 feet wide and artificial manure, we can sow four rows at once,

* See an account of the practice on Mr. Dickenson's farm in the Report on Somersetshire.

and get over 10 acres a-day. Our great difficulty is to secure a plant. Since I followed Mr. Jonas's advice five years ago in doubling the quantity of seed, using 3 or 4 lbs. to the acre, and have also used superphosphate, I have scarcely lost an acre of turnips by the fly, though the fly has sometimes obliged my neighbours to sow two or three times. The superphosphate pushes up the plant quickly into rough leaf, out of the fly's power; and though many be eaten, others take their place, as the seed does not all come up at once. I mention this, because certainty is a very great matter in farming. The next point is economy; and in this too, in looking backward eight years, we have reason to congratulate ourselves on the now general use of sulphuric acid with bones. At first the bones so treated were applied in the liquid form; but the dry form, as I recommended, soon became universal, and superphosphate a common article of commerce. Another method, the putrefaction of bones, is yet more easy to practise. I have found it answer to employ them jointly. The superphosphate pushes on the young plant; the fermented bones feed the tuber as it is formed. The immediate economy effected, in giving an adequate dose per acre, may be stated roughly as follows:—

	Cost of each of the four applications.		
	£.	s.	d.
16 bushels bones	2	2	0
8 bushels bones fermented	1	1	0
3 cwt. superphosphate	1	1	0
1½ cwt. superphosphate, 4 bushels fermented bones	1	1	0

All these doses are rather low; but the *proportion* I believe to be just. Here, then, is a most important reduction in one of the two principal charges of high-farming, the yearly bone-bill. If we double the dose, as is my own practice, and use 5 cwts. per acre, we are within the sum saved from Mr. Bayldon's couch-bill, for which credit, as the reader may recollect, was reserved at the time, and have therefore a right to say that so far *high* as well as *clean* farming is not more expensive than foul farming. The cost is the same; the produce, of course, very different. This, however, by the bye. The turnips come up very quickly and thickly, so that no time must be lost in singling them out. Mr. Jonas advises that a harrow should be drawn across the rows to separate them for the hoers. I find it also a good plan not to let the hoers delay for absolutely *singling* each plant, a tedious matter in thick sowing, but that they should rather strike once with the hoe, leaving the singling to be finished by a troop of children from six years old upwards, who, with their fingers, at 2*d.* or 3*d.* a day, if well looked after, earn their pay well, and are not sorry to leave school for the purpose. From this time Garrett's horse-hoe, exactly

fitting the width of the drill, is kept at work as often as wanted, until the leaves meet, and beautiful work it makes. I would as soon be without a drill as without this implement on my farm. Every farmer knows that a turnip crop is often seriously injured in harvest time for want of hoeing by the hands which are busy with reaping; all which anxiety is cured by a pair of horses and man kept specially at work with this horse-hoe. The crop being well grown, it only remains to feed it well off. To say that for the fatting flock this should be done with the turnip-cutter, which, by saving exertion to the sheep, saves waste of his vital force, and therefore saves food, will sound to most farmers like telling them to plough their land. Still there are districts where even the turnip-cutter is unknown. I have therefore endeavoured to ascertain the profit of turnip-cutting. "If, of two lots of lambs, the one received, during winter, cut turnips, the other uncut turnips, the fold with cut turnips would be worth 20 per cent. more than the other fold. The former would sell for forty shillings a head, if the latter fetched thirty-two shillings, and the cost of cutting would be *one* shilling per head, leaving *seven* shillings clear profit upon each sheep." If this statement had been made by an amateur agriculturist, one would have been rather sceptical. It was given to me word for word by two experienced practical farmers; and I only write it down from their mouths for the consideration of their brethren in any benighted districts of England, or even Scotland, if such yet there be. Let them consider that 7*s*. per sheep upon turnips comes to 70*s*. per acre upon the turnip crop, nearly the average rent of land for the four years' course, till the turnips come round again. And what is the investment of capital? *Five pounds* for one best Banbury turnip-cutter, which will last for five years. We ought to hear no more of the extravagance of high farming. Your real spendthrift farmer is the man—penny wise and pound foolish—who gives whole turnips to tegs, and indulges in the luxury of couch on his fallows. Everybody, too, knows that mutton may now be grown in one year instead of four; and it would be idle to dwell on the excellence of our three great breeds; but it is not so well known how well half-bred sheep answer for early feeding. Thus, from a West Down ewe and a Leicester sire you obtain a teg, with the early maturity of the father and the flavour of the Down breed, consequently fetching something near the top-price in the market. Nay, more, what I do not pretend to explain: it seems that the offspring of the long-woolled and short-woolled parents carries a heavier fleece than either. This cross, I know by experience, pays well. There is another cross in Shropshire highly spoken of. In Northumberland they cross between the Leicester and Cheviot ewes; and Mr.

Colbeck says that the lambs are better shaped, and make better meat than either breed pure.* There is this further advantage sometimes in crossing, that the ewe may be of a breed that can bear hard living upon poor bleak mountain pasture, quite unfitted for the improved breeds. In this way a Welsh ewe might be kept on the moors for eight months in the year, yet her lamb have many qualities of the improved Leicester.

But to return to feeding the lambs. Of course, instead of hay with their turnips they will now have cut straw: and it is very satisfactory to see a barley rick after threshing thus disappear, being minced at once by the chaff-cutter, with the aid of one horse, into a mountain of chaff, which remains in the barn sufficient to last a good flock for three weeks. They must also have oil-cake, the other heavy item besides bones in the account of high farming. Now, I do not say that no additional capital is required for cake; but this I do say: farmers found it answer some years since to pay 12*l.* per ton for linseed cake, which is now fallen to 7*l.* or 8*l.*; and further, I must beg to repeat what was published by me in this Journal three years ago—sheep thrive as fast upon the best London-made rape-cake as upon linseed-cake, and for such rape-cake I have paid hitherto 4*l.* 10*s.* This is really a useful thing for farmers to know; but they must not do as one gentleman told me he had done, give his beast rape-dust, a substance resembling bad mustard flour. Now if it answered to give sheep cake a few years ago, at 12*l.* per ton, surely there can be small risk in doing so now at about one-third of the outlay. But further, as to the mere extent of capital in high farming: if the lambs or tegs begin to receive cake in September, they may also certainly begin to go for ready money to Smithfield in January. Now, the customary credit for cake is three months; the money begins therefore to come in almost as soon as it goes out. I dwell on this point, because exaggerated notions are abroad among practical farmers, as to the expense of high farming, as it is called. The advocates even of improvement set the capital required for improved farming very high. *Ten* pounds an acre is a floating estimate of the proper capital. Farming myself of course high, I cannot bring my own investment to more than *six* pounds an acre, a sum which I believe, with sheep-farming, at least, to be an ample allowance for the highest possible farming. A fair capital, I firmly believe, may be made, by plain, common sense, to go nearly, if not quite, as far in good as in slovenly farming. At all events, when we see the bill for bones and for cake reduced by fully one half, we need not be frightened from good farming by the cost of a few score of ewes to add to our breeding flock; for this is what it comes to at last.

* Report on Northumberland, Journal, viii., 433.

Besides turnips and mangold, other winter fodder crops have been tried. The white carrot is less afraid of drought than the turnip, because its deep root always burrows into moist ground, but he is rather troublesome, from the necessity to dig him up, and to store him ; yet as 30 tons may be grown to the acre, the white carrot should not be abandoned upon free sandy loams. The kohl-rabi, which looks like a swede standing upon a peg, is free from the swede's great enemy, mildew ; is said to give a large weight per acre, and is so sweet that it is preferred by sheep to the swede. I have tried it two years, but cannot speak positively about the yield, because the seed, which comes from Germany, comprised five or six varieties of the kohl, besides two or three kinds of cabbages. The red variety seems very bad ; the pale green the best, having a very large bulb, with a very delicate leaf. The potato is well known to suit the west side of England ; and as food for pigs, does not suffer greatly from a moderate attack of the too famous disease, since they eat it when steamed; and steaming is necessary even for sound potatoes, as they consist largely of starch, the cells of which require to be burst by heat. This is the only kind of farm-cookery about which we may feel certain that it will answer ; at least I feel doubtful about steaming straw ; but potatoes steamed, mashed, mixed with barley meal, and left to turn sour, will, I know, fat a hundred hogs well in an open farm-yard. I mention this, because desirable as good buildings are, that work must be a slow one, and we cannot wait until it is done. In agriculture, as in other affairs, shifts must be made. If our cultivation be not improved until all our farmers have ten pounds per acre of capital, and all our landlords have put their buildings in apple-pie order, many of us, I fear, may never begin. There is another tuber, the Jerusalem artichoke, which, as food for stock, may be substituted for potatoes, and does not require to be cooked, because instead of starch it contains a similar but peculiar substance, Inuline. Its yield I have found to be on a par with the potato, about 10 tons, and it is equally nutritious. It is a field crop in Alsace ; and I have a piece which has stood for five years. It is the least troublesome of all crops, taking care of itself. The roots are dug up when wanted in winter, dreading no frost ; and so many remain behind, that you have only to give a ploughing in spring, with a coat of dung, if required. It deserves to be tried on a small scale, in any out of the way field. Returning, however, to regular cropping in the four-course system, we next come to the

Second Year.—Barley.

The chief question about barley is the time of sowing, and many

farmers now sow it, notwithstanding its tenderness, as early as February, the object being that it should be up high in May, so as to shade the ground and keep that moist in May droughts. Late sown barley will sometimes not grow two feet from the ground. Barley sown in February gives the best quality—sown in April, the largest bulk, that is if no drought ensues. As one chief point in deciding the question must be the power of barley to endure frost, and it is known not to stand through the winter, I ought to put on record a fact which came under my own observation this year. Early in March we had very severe frosts, and one night in particular my self-registering thermometer marked 11° of Fahrenheit, that is, 21° below freezing point, an amount of frost which is not experienced sometimes in a whole winter. My early sown barley was out of the ground in full blade, and I watched it with curiosity, but it did not suffer at all. It might have suffered if the land had been out of condition, for condition has the curious property of enabling grasses, even Italian rye-grass, to withstand frost which they could not otherwise resist, as I have often remarked. To sow thus early we must plough quickly after the fold, and it appears to me that there is little risk in ploughing turnip-land, however miry from sheep, during winter, because the first good frost will reduce it to a fine mould. In spring, indeed, it might grow hard, if ploughed when too wet, and became therefore difficult to render as fine as barley likes its seed-bed to be.

Third Year.—Clover or other Seeds.

I wish I could report any progress in our knowledge of the clover-sickness, by which the growth of clover is almost stopped in some light-land districts of the north, especially Yorkshire, and for which every remedy proposed has hitherto failed. It is only mentioned here in order to stimulate, if possible, further endeavours to fill up this blank in our scientific and practical knowledge. In Cambridgeshire, where the clover-sickness, however, seems not so severe as in Yorkshire, Mr. Jonas says,—

> "Many of our best farmers now sow red clover only once in 16 years, getting the seed-shift into the following rotation:—1st. white clover; 2nd. trefoil; 3rd. peas or tares, fed off or seeded; 4th. red clover. Thus only can we now obtain good crops of red clover."

There is another point about clover which deserves chemical inquiry, the use of gypsum upon this crop. In Germany and North America its use is widely prevalent, and the result great. In England it has been known to double the crop of clover, but we cannot tell beforehand where it will answer; nay, on the same field, a farmer informed me it answered on one part and failed on the other. According to Boussingault, it fails on moist land and answers on

dry land. If sprinkled during spring in dripping weather or on a dewy morning, it adheres to the leaf, and has been known to push the plant so as to cover the ground, and keep it moist to this degree, that the gypsed clover becomes a good crop, while the ungypsed clover is burnt up by the drought. Peat ashes are applied here in the same way with the rising sun, and they consist largely of gypsum. It seems almost certain that this mineral manure is absorbed into the leaf of the plant.

Fourth Year.—Wheat.

There is no crop about which we should be so cautious in speaking as about the wheat crop. If you give a root crop more help than is necessary, you waste so much money unless the manure remain in the ground; but if wheat be over-fed, in a wet season it goes down, or in a dry, cold May it is mildewed. Last August I observed, beyond mistake on a close examination, that the better the land the more was the wheat mildewed; the better farmed the same land, the more was it also mildewed, and that the only bright yellow crops, neither mildewed nor laid, were to be found on cold clay lands, rather out of condition. It is evidently impossible, therefore, to propose any general rule for its culture: Mr. Lawes has shown that what it wants is ammonia. All our received wheat manures are in fact nitrogenous,—dung, woollen rags, rape-cake, but the test of a practical farmer is to hit the right mean. Any one can make his wheat look green in winter, but the experienced eye does not like it to look grassy at Christmas. Even if it be right then, the east winds of February or March may set it wrong. The plants change colour and disappear, one knows not how, some with the wireworm; at last (I am speaking of light land) large patches of ground become almost bare. Rolling and wheel-pressing are good against this; but the clod-crusher, which dints the ground like a flock of sheep, is the best of all. We may also venture, but with great caution, to top-dress with guano, or even, as is done by one of the best farmers in Norfolk, with about 3 cwt. of nitrate of soda, adding 2 cwt. of salt to strengthen the straw, an effect of salt upon some land that has been known many years, though I have not found it so act upon my own farm. Wheat plants, however, so thinned and so stimulated, are inclined to tiller unduly, whence mildew may follow. If we could eradicate one cause of this failure of plants, the wireworm, we should do much, and of all the methods, one proposed in the last Journal by Mr. Charnock * seems the most promising,—a top-dressing of 5 cwt. of rape-cake per acre broken in lumps. The wireworms are said to eat their way into these lumps, and

* Vol. xi., p. 183. It appears by Mr. Curtis's paper on the Wireworm, that Lord Albemarle also recommended the same remedy.

therein to find the grave of a glutton. Be this as it may, the rape-cake, if not a vermifuge, is a certain manure.

Having said so much on the danger of overmanuring wheat, I may now call the farmer's attention to a most important statement, from one who, by his patient research, careful experiments, and faithful reports, has done more than any man living for the safe union of farming and chemistry,—I mean of course Mr. Lawes, our highest authority upon such matters. It is well known that in Hertfordshire he has tested the action of manures by growing successive crops of turnips and also of wheat repeated upon the same piece of land, the crops being withdrawn, and no portion of them returned to the ground. The result of his long-continued trials with wheat is as follows:—

"With the prospect of low prices in wheat, it is a question of much importance to know whether money can be profitably laid out in the purchase of artificial manures; I will, therefore, state briefly the results I have obtained upon my own farm in growing wheat for seven successive years in the same field.

"The unmanured portion has varied but little, from first to last, growing *seventeen* bushels per acre. No combination of manures or salts, not containing ammonia, has been able materially to increase this amount.

"By means of ammonia, a produce of *thirty-five* to *forty* bushels per acre has been obtained. From four to five pounds of ammonia have generally been supplied to produce each bushel of wheat; and although this amount may not accurately represent the supply of ammonia necessary to produce each bushel upon every soil, still it may be taken as a guide to the quantity required. Upon all soils having a moderate proportion of clay in them, it is advisable to sow the guano in the autumn; two-and-a-half to three hundred weight per acre are sufficient; it should be sifted finely and sown broadcast at the same time with the seed.

"The cost at which ammonia can be supplied to the soil must therefore be carefully considered, as upon this one point the profit or loss depends. Peruvian guano ought to contain 16 per cent. of ammonia, of which each pound will cost a trifle more than sixpence. At the present price of wheat, guano can therefore be employed with profit."

The unassisted produce of the Rothamstead land, 17 bushels, or 2 quarters per acre, is, I suppose, about the natural produce of our average turnip-lands. The assisted yield is that of the same land under the highest farming, 35 to 40 bushels per acre, or 2 quarters more. The cost of the extra produce per quarter is the price of 36 lbs. of ammonia in guano, or 18*s.* per quarter of wheat. Now be it observed, that the difference of 18*s.* and 40*s.* for these additional quarters of wheat is utterly independent of all the expenses of cultivation: those expenses, with rates, tithes, and taxes, must all be incurred if you are content, as I know some farmers are, with 17 bushels per acre. The only deduction from the profit upon the extra quarters is for casting the guano, a mere trifle, and some extra charge for harvest and threshing. So clear a case of advantage, and so conclusive an

argument for manuring, was never put upon paper; for, instead of intricate and interminable calculations of the cost of breeding or fatting stock to produce manure, the whole question is put in a nutshell: Will you or will you not venture *one* pound at seed-time, to get back *two* pounds at harvest? If a bad farmer were told that he could treble his turnip crop, he might dislike buying more sheep for feeding it off; but here is a clear statement of expense which requires no companion outlay—a simple outlay which begins and ends with itself. A bad farmer may go on with his no crop of turnips still—the whole routine of his farm may remain undisturbed; but I really cannot see how the worst of farmers will escape these extra bushels of wheat. Mr. Lawes, I see, recommends that the guano should be broadcast rather than drilled with the seed. As he has doubtless good reasons for this advice, I may mention that either the sowers of guano should keep a smock-frock on purpose, since it injures the workmen's clothes, or, better still, that a dry-manure distributor * should be bought for four pounds. I need scarcely add that the dose of guano must be suited to the condition and strength of each field. The principle alone is fully established.

Such is the improved four-course or rather five-course system. There is one other crop—flax—which must not be passed over before I conclude.

Flax.

Its value, as now grown in Ireland, is rated by Mr. Macadam at 19*l.*; the outgoings at 9*l.*; the clear profit at *ten* pounds per acre. His prize report,† published by our Society, being most complete, and of the highest authority, must be consulted by those who would embark in this branch of husbandry. The obstacle to the wider growth of flax has hitherto been the number of new processes which its preparation involves. The cultivation, indeed, is somewhat peculiar, as in Belgium one may see it weeded by women creeping on their hands and knees; but the fitting it for market requires many unwonted and delicate modes of handling, as rippling to rend off the seed, steeping to rot the stalk, spreading and turning to dry and clean it, bruising to loosen it, and scutching to separate the fibre. Upon these its market value greatly depends. It is only by skilled hands they can be well done; and skilled hands will be found only in a district where flax is already grown, or must be introduced by a combined effort of neighbouring landowners. Steeping, indeed, is now performed by a hotwater apparatus, and scutching by a

* See Implement Report for account of Dr. Newington's dry-manure distributor.

† Macadam on the Growth of Flax, Journal, viii. 361. Also Nicholls on Flax, viii. 438.

mill; but it will not do for these things to be at a distance. If you send away the stems from the farm before steeping, you part with all its manuring matter. These are real difficulties, not insuperable, of course, but which must be weighed before embarking in the growth of flax—unless, indeed, the new processes now under trial, which dispense with steeping, and are even said to convert flax into a substance like cotton-wool and silk also, should be found to succeed. Then, no doubt, there will be a wide extension in the growth of flax, limited only by the supply of manure; nor would that, in truth, be a limit in our days, because the supply of guano is unlimited. Flax, too, though it requires high preparation, like wheat, is not so fastidious as to soil; it has been grown on an Irish bog reclaimed but three years, and was sold for 70*l.* per ton; nor is it so tender as wheat in the elevation at which it thrives, having succeeded in county Wicklow, at 1060 feet above the sea, far beyond the level of wheat.

There is one most important point in our favour as to the growth of flax. "Insular countries, or long lines of coast," says Mr. Macadam, "whose position insures a more equable temperature, and a continued supply of moisture, from spring till autumn, are found to produce the best flax." Even in Russia, the short, hot, northern summers hurry the growth, and the fibre is coarse, so that the best Russian flax fetches but 48*l.*, while the best Belgian reaches 150*l.* or 180*l.* per ton. Hot southern countries, again, alter the character of the plant, making it short and branchy. "Egypt," we are told, "is the only hot country which furnishes any fibre to our market," and that has not passed 44*l.* per ton. The hot summers of Russia and Egypt cause a dryness and brittleness of fibre, and prevents its retaining that elasticity, pliancy, and oiliness which characterise the flaxes of Belgium, Holland, and Ireland. In America it has not succeeded hitherto for fibre. In some respects, Mr. Macadam says, our climate is even superior to that of Belgium for flax, since in Belgium severe droughts in spring scorch the young flax, and even kill it once in three or four years. It is right, however, to mention, that on one point our own sky is inferior. Flax dreads heavy rain in July, which lodges and discolours the crop. On the whole, it seems clear that our climate is specially adapted to the growth of flax, but some districts more so than others; and it is plain that the better knowledge of our own climate, which meteorology has lately given us, will assist in the selection of favourable localities; thus illustrating remarkably the legitimate application of science to practice, and showing the advantage of storing, as it were, scientific facts, which though of no apparent use now, may be ready for application when wanted.

Such are the main points of improvement which twelve years have brought to our knowledge, many of them not new, but true,

as founded on long experience, yet many also new, but equally certain. Every soil it appears may be improved cheaply if suitably treated. If the landlord cannot spare the money out of his income, the tenant should endeavour to find it on sufficient security out of his capital. The tenant's improvements, again, are cheap as well as effective, and high farming I have endeavoured to prove is not extravagant farming. But a slur is cast on agricultural improvement, because it is said those who practise it do not make it answer. Now the notable cases of improvement are those of gentlemen who farm their own land. They are apt to be misled by crotchets, but the chief defect is the want of active inspection kept alive by dependence upon the farm for support. While they are asleep or absent their labourers are idling; when they buy their stock or sell it, they buy in the dearest market and sell in the cheapest, and they have no check upon their accounts. One of our greatest agriculturists held his farm without gain, as Lord Spencer told me, for a long course of years, yet was offered for it by his own manager at last a rent of 1000*l.* a year. That gentleman's tenants meanwhile, by the same improvements, were growing wealthy. There is, however, even for an amateur farmer, one certain test by which he may know whether a practice he adopts be an improvement or not: the test of the practice of the best farmers. Do good farmers buy bones at such a price? If superphosphate cost one-half and act as well, it must pay better. Do they buy linseed-cake? Then if rape-cake at half the price feed the sheep quite as fast, it pays better. There is indeed a source of loss which lies in the *misapplication* of practices, as when some one complains that he has ploughed 10 inches deep for wheat and has got a bad crop, while we know that wheat requires a hard bed; or in the transfer of systems, as from an eastern corn-growing county to the mountains of Wales. A gentleman, who farms on principle, or, still worse, on system, will be lucky, indeed, if he pays his own rent. In the worst-farmed district among the least enlightened farmers, if I sought to improve them, I should begin by finding out what are their prejudices, for in those prejudices will lie the peculiarities of the soil and the climate, so that in Wales an improvement of the worst Welsh farming may beat Ickleton or Castleacre transferred to the mountain sides. Books will not teach farming, but if they describe the practices of the best farmers, they will make men think and show where to learn it. If our farmers will inquire what is done by the foremost of them, they will themselves write such a book of agricultural improvement as never was written elsewhere, in legible characters, with good straight furrows, on the broad page of England.

Pusey, November 22, 1850.

Note.

On the Formation of Tanks; extracted from Mr. Hannam's Paper on Waste Manures.—Journal of Yorkshire Agricultural Society, No. 6.

"Mr. H. S. Thompson, of Kirby Hall, at the late meeting of the Yorkshire Agricultural Society, at Doncaster, recommended the plan he adopted, which was 'to have a pit dug in the earth in which to throw the manure, instead of having it piled up on a heap. The bottom of the pit is watertight, and has a slope towards the centre, where a tank is placed so as to receive the drainings from the manure. These drainings are frequently poured over the manure, so as to keep up a regular, but not excessive fermentation. He was in the habit of collecting all the couch-grass, stubble, and other vegetable refuse which the farm afforded, and spreading it on the bottom of the pit to the depth of six or eight inches. This, when well soaked with the liquor that drained from the manure which was carted upon it, and fermented together with that manure, was, he believed, as good as any other portion of the heap. In this way he had last year on a farm of two hundred acres of arable land increased his manure by two hundred single-horse loads, which was equivalent to four additional loads per acre for his fallow crops. If the manure was wanted for immediate use, it should be lightly thrown together, and after being well soaked with tank liquor, have a thin covering of soil to absorb the gases which would otherwise escape. In this case it must be carefully watched and well watered, from time to time, to prevent the fermentation from becoming excessive. If the manure is to be kept six months or more, it should be made solid by carting over it, and have a thick covering of soil, which would nearly exclude the air. In this way manure may be preserved for a year almost without loss. In very dry weather, the drainings from the manure are not sufficient to keep it moist, and it becomes necessary to saturate it with some other liquid. If the farmer has other tanks on his premises, it would be better to use their contents for this purpose; but where such are not at hand, plain water may be used, and has been found to answer exceedingly well.'

"Having had the pleasure of examining this process, I may add in explanation, that the pit is merely an excavation, similar to a shallow gravel quarry, one side being sloped away for the purpose of convenience in emptying it of manure;—hence the cost would be slight. In some situations the gravel taken out would pay for the labour, in others the soil would be of great use, for the purpose of covering the manure (when intended to be kept fresh), or as an absorbent for the liquid and gaseous waste.

"Mr. Thompson's pit is so formed that the liquid filters gradually into a small well or tank, at the bottom of the excavation,—this tank being merely a cutting, about six feet deep, six long, and three wide. Of course, when the compost is made in the pit, the tank is left uncovered, the manure being piled round it, so that the liquid may be laded out and spread upon the compost. When the manure has to remain in the pit for a length of time, it is generally covered with soil and other absorbent matters, by which means it is kept fresh. Indeed, so well is the object effected, and all *gaseous* escape prevented, that nine out of ten individuals would walk over the pit without knowing that there was such a store of rich manure under their feet.

"Mr. T. has also a capacious tank, in which the liquid from the sheds and the yard is collected. This tank, however, is totally unconnected with the compost pit.

"Of the various plans which we have examined, Mr. Thompson's is most entitled to our notice. And this not merely because it is in practical operation, and has shown beneficial results of which we have abundant evidence, but because it is calculated to secure each of the advantages flowing from the other methods, without their disadvantages. For instance, it affords us the means, not only of collecting the waste fertilizers, but also of preserving them, and of using them in conformity with the principle best adapted to English agriculture, viz., *that of concentrating them as far as possible in our farm yard compost, or using them singly, at option.*

"In the *modus operandi* of this plan there are, however, certain defects. They do not belong to the system, but are errors of arrangement, and as such may be remedied. One of these errors is in the position and locality of the liquid manure tank, which is at some distance from the compost-pit. Owing to this circumstance the solid manure is only *saturated with the liquid that it brings with it from the yard,* except at the expense of extra cartage from the tank. In cases, therefore, when the drainings from the pit are not sufficient to moisten the compost, (a circumstance which Mr. Thompson states does happen,) or when we may have a quantity of dry vegetable matter, which is slow of decomposition, to form into compost, we must either take the trouble of frequently carrying the liquid from the tank to the pit or (what *may* be equally troublesome, and must be always a bad practice, when liquid from the yard can by any means be obtained) adopt Mr. T.'s own alternative, and '*use plain water.*'

"Were the tank formed near the pit, this evil would be removed;* the drainings from the fold-yard would be quite sufficient for saturating the compost, and the work would be performed with little trouble. It may be said that nothing can be done *without trouble,* and that the carriage of the liquid would be amply repaid in this case. This may be true; but let it not be forgotten, that, strictly speaking, if we are ever so well remunerated for spending a week over any work, we are much better paid if by any means we can perform it in half the time. But it is not on this account that unnecessary trouble is objectionable in a plan like this, but *because it too often leads to more serious evils.* Thus, say we have a compost requiring frequent applications of the liquid, and it is a work demanding a little extra preparation; it is perhaps accomplished once properly; next time, however, it may happen that we are busy, and it is hurried over, and only half done; on the next occasion, perhaps, time cannot be found to attempt to do it; and so on, till at last it is forgotten altogether. We do not say that this would be a common case; when, however, we can so easily prevent the probability of it happening at all, it is our duty so to do.

"Having now seen upon what principle our system of economy should be based, and how far the various measures proposed are calculated to carry out that principle, we are in a situation to say how, and by what particular means, that object may be generally effected, and the waste manure of every farm properly economised. To accomplish this thoroughly will require an arrangement more comprehensive than any yet detailed. A careful examination, however, of the advantages and disadvantages of the preceding plans warrants us in asserting that it may be done, both effectually and economically, by attending to the following suggestions:—

"1. Let all the buildings round the farmyard and strawfolds be spouted,

* Mr. Hannam's criticism is just; but the arrangement he complains of could not, in my case, be avoided, as my tanks were made before I had even conceived the idea of making a manure pit, and the ground would not admit of the manure pit being made in the immediate vicinity of the tanks.—H. S. T.

and the delivering tubes so arranged that the water may be made to flow into the yard or not, at the option of the farmer. This may be effected by bringing the end of the spout over a drain, which may be left open or closed, as he may wish the water to escape from the yard or not.

"2. Let the farmyard, if possible, be made slightly concave, so that the liquid may permeate the mass, and make to the centre.

"3. Make drains from every stable, cowshed, &c., and from the kitchen into the manure yard.

"4. Select a shady place, if possible on the north side of a hedge or wall, where it is convenient to cart the manure to, when it is removed during winter and spring from the fold. Mark out a surface sufficiently large to hold in a heap all the manure made during winter, and form a compost couch of this size, and two feet deep. Divide this couch into three sections, by two rows of flags or bricks. Make the bottom of each couch incline, so that the liquid from the manure may gradually fall to the front side.

"5. Next cut a drain alongside, and in front of the couch, with an inlet from each division, through which the liquid may flow into the drain, and fix a sluice at each inlet.

"6. Make a capacious tank, on any convenient side of the couch, and connect it with the drain which runs alongside the couch, so that the liquid from the couch may run into the tank.

"7. Make a drain from the bottom of the farm yard into the tank, and fix a sluice, so that the liquid from the yard may be let into the tank or not, at pleasure.

"8. Fix a pump over the tank, and connect the nozzle with a wooden spout, fixed so as to traverse above each division of the couch.

"9. Bore a hole through the spout over each section of the couch; in each hole put a plug on the top side of the spout; also over each hole affix on the under side of the spout a leathern nozzle or delivering tube, two or three feet long; by means of which arrangements the liquid from the tank may be directed to any part of the couch.

"These arrangements may be made at a slight expense, in almost any locality, and worked with little trouble by the farmer, so as to give him a perfect command over his manure; that is, to enable him not only *to preserve the fertilizers which are usually wasted, and to concentrate them in the form of compost or otherwise, at pleasure;* but also to *make and preserve* this compost *for any length of time, in whatever condition he may think fit.*

"Thus, to PREVENT WASTE, the process is as follows:—The liquid drainage from the sheds and house, which is not wanted in the yard, and also that from the manure when carted out of the yard into the couch, is collected in the tank. One section of the couch forms a place of deposit for all *vegetable refuse* which can be gathered together; while *gaseous waste*, arising from too active fermentation in the cattle-yard, may be prevented by the power which the spouts and sluice-drain give us of keeping the manure dry or wet at pleasure; for, be it remembered, that while a little moisture encourages decomposition, a liberal supply prevents or retards it, and also absorbs a large portion of the ammonia which is evolved during the decomposition which does take place; for ammonia and all its compounds are easily soluble. When therefore the manure is led out of the yard by placing it in one section of the couch, we can, if we wish the manure to be kept fresh, have a liberal supply of liquid from the tank, and can let it remain in the couch as long as we think fit, by keeping the sluice at the junction of the couch, and the drain which leads to the tank, closed. By carting over the heap, making it as solid as possible, and covering it up with ashes, charcoal, peat, earth, or any other absorbent, the loss of

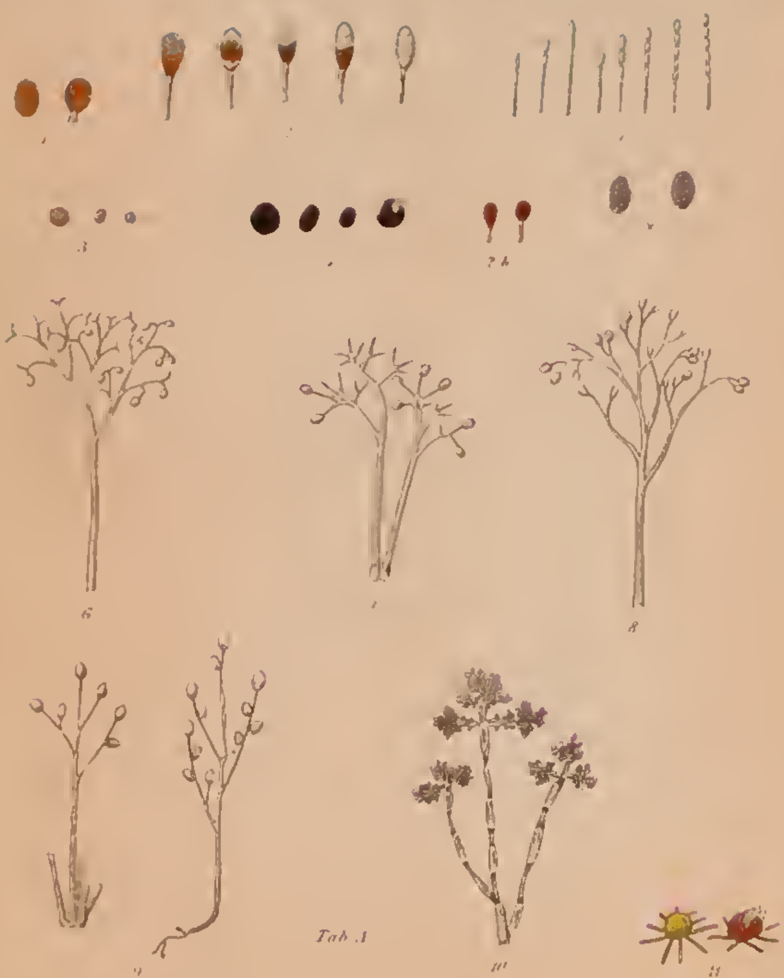
ammonia will be very slight. When, however, we require the manure in the couch to undergo very quick and active fermentation, and are compelled to throw the manure lightly together, and to drain away unnecessary moisture, our best method of preventing *gaseous escape* is to cover the heap lightly over with ashes, sawdust, peat, charcoal, or other absorbent, and to keep this coating well saturated with sulphuric acid and water, say a weak mixture of ten gallons of water to one of acid. . . . .

"To combine the various waste matters *with our ordinary compost*, the system affords us every facility. Thus, the *liquid* from all the buildings flowing into the tank, we have nothing more to do than to lead our manure from the yard upon one of the beds of the couch, where we can, by taking out the plug from the spout over the portion we wish to saturate, pump upon it, if we think proper, the whole contents of the tank. With this compost we can also mix the *waste vegetable and other refuse*, which have been collected in the other section of the couch, or can, by opening the spout from the pump, make a compost of it, with the liquid from the tank only. The *gaseous matters* are in this or other cases preserved and combined with the bulk of the compost by *the* means before detailed.

"To make and preserve *our compost manure in whatever condition we may wish it to be for any length of time*, is another of the advantages which we have said the system gives us, and it is thus secured. In the farmyard, by opening the spouts and stopping the drain leading to the tank, or *vice versâ*, we can retard or accelerate the decomposition of any vegetable matter; and, when we think fit, can lead it out into the couch, where we prepare it, and preserve it in any condition we may think proper. Thus say we have one portion which we wish to keep fresh for a length of time; we have nothing more to do than to saturate it well with the liquid from the pump, and to keep it pressed down and thoroughly wet, and covered with earth or vegetable refuse, so that the atmosphere cannot have access to it, when our object will be effected. Another portion, which we may wish *to decompose thoroughly*, we can place in the other section of the couch, throwing it lightly together, and frequently applying the liquid from the tank. In this case the drain from the couch should be open, in order that it may return all the liquid that the compost does not absorb, and thus keep the manure from being too wet. Again, *to make our compost in as good a condition as it can be* for use, we can saturate it thoroughly with the liquid from the tank, and apply it in as wet a condition as possible. By this means we excite a fresh action in the manure, which is of immediate benefit to the young crop (especially to turnips and green crops), and convey a stock of liquid food with scarcely any extra carriage. My own experiments (p. 49), those of the late Arthur Young (p. 48), and the practice of the Flemings (who moisten the small heaps of compost laid out at regular distances in the field, and as soon as they begin to heat plough them in),* are proofs of the beneficial effects of this process.

"In executing these various processes, the means which have been laid down for the prevention of gaseous waste may be employed. And, lastly, after having *preserved all waste;—concentrated as far as possible the fertilizing matters of the farm in our manure heaps;—preserved them as long as we think proper;—and applied them in the condition best adapted* to promote vegetation, our *tank* supplies us with the means of applying a *liquid* dressing to any light sandy soil, or to any crop which we think requires it, or whenever our solid matters for making compost are exhausted."

* Agriculture of the Netherlands, Royal Journal, vol. ii. p. 57.



Tab A

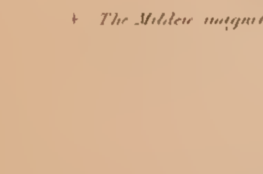
Tab B Fig 1 Botrytis parasitica on Shepherds Purse

3 Effects of the Botrytis (2) Uredo candida

* Drawn from blade of Wheat Aug 3 1850

a This plant has shed its spores

Tab C Fig 1 A young potato shoot growing where it was stored; the spots showing the effects of the Mildew Oidium Solanum (2) A portion of the bark showing the mycelium amongst the healthy cells (3,3) Healthy glandular hairs of the shoot bearing tufts of the above Mildew a a (4) Hairs partly killed by the same Mildew (5) Mycelium of the Mildew



Tab D

‡ Puccinia Graminis on thin sown Wheat 1847

† The Mildew magnified—from Bauer

Tab E

1 Uredo Senecionis on the Stem and underside of leaf of Groundsel the brown spots on the surface of the leaves, being caused by patches of the Uredo beneath them

2 A Stem of Groundsel containing brown blotches and dead leaves resulting from the action of the Uredo

Tab F

1 Black bent bearing Ergots

2 Sphacelia segetum on their surfaces

3 The same more magnified

XXIII.—*Observations on the Injuries sustained by certain Plants from the attacks of Parasitic Fungi; with particular reference to the cause of the Potato Disease.* By F. J. Graham, B.A., F.L.S.

Several eminent botanists have taken great pains to reduce the various tribes of fungi into their proper systematic divisions; but, except in a few particular cases, sufficient attention has not been paid to the injuries which those of a parasitic nature produce. It is not to be wondered at therefore, that the public should receive an announcement that the potato was destroyed by such means, with a certain degree of incredulity.

The cereal fungi having already been ably treated of by Professor Henslow in this Journal, it will scarcely be necessary for me to make a remark upon them. Uredo rubigo—Rust (fig. 1) first appears on the blades of wheat in spring; and several circumstances favour the opinion held by the above learned professor, that it is merely an early stage of Puccinia graminis. It is found on the same blade—is nearly of the same colour, and is also found frequently with short pedicels. In a beautiful engraving by Edwards, executed for the late Sir Joseph Banks, rudiments of these are shown both above and below the surface; but the globular sporidia appear to be thrust off by each other in consequence of growing in such dense heaps. Some specimens of Puccinia graminis, which I have seen and drawn (fig. 2), contain bodies within their sporidia, exactly resembling common forms of uredo. On the other hand, the uredo is usually dispersed in spring, and whether it be an early form of Puccinia or not, I believe its sporules are perfectly capable of vegetating in that stage of growth. Uredo leguminosarum, on the bean, is nothing more than the sporidia of Puccinia fabæ, having no independent sori; and Uredo rosæ certainly passes into Aregma mucronatum, on rose leaves, which is the same as A. gracile—on those of the raspberry. My last figure of Puccinia graminis has also nearly the same structure as this Aregma.

Puccinia graminis—Red gum (fig. 2), by bursting through the epidermis of the sheaths and stems of wheat, tears it into strips; and by intercepting the natural supplies of the grain, causes it to become light and inferior. Sir Joseph Banks states, that in consequence of its prevalence in 1805, a sack of wheat did not yield more than a stone of flour. It is first of a reddish colour, but afterwards turns black.

Uredo caries—Bunt (fig. 3) occupies the ovary of the grain of wheat from an early period; and as this expands it becomes filled with the large dark globular sporidia of the fungus, instead of flour; to which, when ground, it imparts a rank fœtid odour. The ears

infected by this fungus have a sickly green colour, with a whitish cast. Although the most dreaded by agriculturists, it appears to be the most easily prevented, by pickling the seed grain, of which there are two or three well-known methods.

Uredo segetum—Smut (fig. 4) occupies the ovary in the same way as the last; but ruptures it usually before the ear is protruded from the sheath; which appears at length covered with a smutty powder, containing the black opaque sporidia, which are much larger than those of U. caries, but without their unpleasant odour. This generally destroys the entire ear; but as the sporidia easily burst, and are always washed off by rain before harvest, farmers do not probably calculate their loss to be so great from this fungus as it sometimes is: for I have seen fields in which nearly one-fifth of the ears were rendered abortive by it. It appears, therefore, that the means employed effectually in preventing the Bunt do not produce the same result upon this species.

Spermoedia clavus—Ergot, on rye and other grasses, after frequent investigations by men of science, still remains in doubt whether it be a perfect fungus, or a monstrous form of the grain, caused by fungi or insects. Having recently found many Ergots on the black bent, Alopecurus agrestis (Tab. F. 1), and examined them carefully while fresh, I find their pruinose coating to consist of small white blisters, which at length burst, and tufts of moniliform spicula protrude in all directions (Tab. F. 2). These being exceedingly delicate, break up under the least friction, and are dispersed; but the joints of which they are composed (fig. 3) being glutinous, adhere to the parts on which they fall. Mr. E. J. Quekett has given several beautiful drawings of this fungus, which M. Léveillé has named Sphacelia segetum, from its producing gangrene. The ovule of the grain is no doubt impregnated by the spores of this fungus being carried up in the sap in the same manner as those which contain Bunt and Smut; and its presence causing a constant irritation and struggle on the part of the plant to throw it off, distortion and enlargement of the grain is the result. Insects produce galls by similar means; and branches of the juniper-tree are enlarged to twice their natural size where attacked by Podisoma juniperi; and the stems of Shepherd's purse, where infested by Botrytis parasitica (Tab. B.), are swollen to four times the size of the parts adjoining.*

The common bean is attacked in most seasons by Puccinia fabæ (2 *b*), which checks its growth and lessens its produce; but I believe it suffers much more from insects.

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* I lately found a number of Ergots amongst barley in London. Parties should be cautious as to what uses such samples are applied; indeed the sale of them should be prohibited altogether.

The pea is frequently clothed with the white mildew Oïdium monilioides (fig. 5), occasionally succeeded by, and often confounded with, Erysiphe communis, from both being found on the same leaf; but as both species have distinct spores enclosed in very different receptacles, their connexion must be accidental; and as this Oïdium infests a great many other plants, I propose calling it Oïdium commune. I should not venture on this innovation, had I not carefully examined every plant which I shall name as being attacked by this species, under a high power of a compound microscope, and satisfied myself that no difference exists, except that which arises from the nature of the plants on which it subsists, and between a young and mature specimen of the fungus itself. I have also grown it on the pea and other plants by scattering on their leaves spores from mildewed grapes. Among the plants attacked by this mildew are the cucumber, melon, and gourd; all the varieties of cabbage and turnip; dogwood, acacia, maple, sycamore, and apple-trees; rose, gooseberry, and peach-trees; the hop and grape vine; the verbena, aquilegia, and several other flowers. Its effects are more or less injurious, in proportion as the plants on which it grows are hard and tough, or tender and succulent.

Cucumber and melon plants are soon overrun, rendered unproductive and eventually killed by it. The cabbage becomes stunted; the leaves turning yellow beneath the mildew, and soon rotting. Yellow spots also ensue on the leaves of turnips, causing them to fade prematurely; the bulbs become pithy, frequently spotted inside, and keep badly when stored. The leaves are, at the same time, subject to the attack of Botrytis parasitica (8), which produces similar results. The leaves of the sycamore and other trees, although not often destroyed by this mildew, on account of their tough nature, are still so choked by it, that they cannot perform their proper functions, and the trees do not thrive. It kills the young shoots of peach-trees, and spoils the fruit—and prevents the rose from blooming in its full beauty. On the hop plant, its effects are well-known to be so destructive, that it is quite unnecessary to describe them. The grape-vine appears to have become a much more recent prey to this pest—my first experience of it being in 1846, and I have not heard of any one who had noticed it previously. I was walking at the time in the garden of the Horticultural Society, discussing the subject of the potato mildew with Mr. Thompson, when a vine at the end of one of the hothouses (outside) attracted my observation; the leaves being thickly spotted with patches of this mildew. Next year, many crops were attacked by it, both indoors and out; and last year it became general, in many cases destroying the entire crops. It is remarkable that the mildew attacks the fruit, leaves, petioles,

and young shoots; and wherever it appears, the parts beneath it always turn brown. The verbena and other half-hardy plants are also frequently killed by it; many of those above mentioned being simultaneously infested by Erysiphe communis (11) as before alluded to. This commences in small glossy yellow globules which turn brown when mature; they are attached to the plants by their own independent fulcra, and have no natural connexion with the Oïdium. Dr. Greville supposed that the peridia, or receptacles of the spores, burst in a circular orifice in order to emit them; but on subjecting them to pressure, which I think the most likely means of discovering their natural mode of deshiscence, I have always found them split from the top downwards; the spores being contained in a few transparent sacs, which also easily burst.

The haulm of the blue pea is often clothed with Botrytis viciæ (fig. 6), which invariably kills it. The tare plant is frequently attacked by the same species, and in 1848 I observed several patches die off suddenly under this visitation, the roots and lower parts being, however, at the same time in an unhealthy condition, apparently from too much wet. Dark blotches arise also both on the stems of this plant and the bean, succeeded by Botrytis vulgaris (fig. 10), which, however, is seldom found on the living, healthy portions of any plant.

The leaves of parsnips during the two past years have been nearly covered with large white patches of Botrytis ganglioniformis (fig. 7), which produced brown blotches and soon killed them, the mildew being quickly dispersed after it attains maturity, so that no one examining the leaves after the white spots were gone would be able to detect the cause of their decay. In this respect they bear a close resemblance to the leaves of diseased potatoes. The roots were sound, which seems to show that they contain some antiseptic property in a higher degree than the potato; yet it has been recorded in the Gardener's Chronicle that the roots have also been diseased in a similar manner.

Young lettuce plants frequently suffer from the same species of Botrytis, and, if thickly planted, it soon thins them most effectually.

The top shoots of the wallflower are likewise attacked by this species, which gives them a swollen, gouty character, and ultimately kills them.

Having thus far briefly noticed the injurious effects of a few species of parasitic fungi on plants chiefly of exotic origin, sometimes causing a diminution of produce, in other cases a premature decay of the parts attacked, and eventually the destruction of the entire plants, I will now relate the effects produced by similar agents on several hardy, indigenous weeds.

The common plantain has been covered with Oïdium com-

mune (fig. 5), which stunts its growth and turns its leaves of a brown colour; but, on account of their tough nature, is unable to destroy them.

The same species attacks several sorts of poppy on the leaves and stalks, producing moist blotches on the latter in damp weather, and frequently killing the plants.

Wild angelica and other herbaceous plants suffer in a similar way from the same species as the last, as well as from the attacks of Botrytis gangliouiformis.

The leaves of the common stinging-nettle are infested by a smaller species of Oïdium, which grows in dense tufts, and closely resembles a species which I have found on the young shoots and roots of the potato. It causes the leaves to curl back, when they appear covered with the white mould, but soon after turn black and die. I have also once or twice found a species of Botrytis on the leaves, which I presume is the Botrytis urticæ of Mlle. Libert, but it seems to be rare in this neighbourhood on the above plant, and closely resembles B. parasitica. A bunch of nettles with its leaves reflexed and spotted with mildew presents nearly the same appearance as potato haulm under the attack of Botrytis infestans.

Groundsel is often much infested by Uredo senecionis (Tab. D. 1), as well as by Botrytis ganglioniformis and Oïdium commune, and the effect produced by them is precisely similar to that of Botrytis infestans on the potato plant; the leaves and stems, however luxuriant, soon become blotched beneath the mildewed spots, and the latter double down at the places where the thickest tufts had grown; the leaves (D. 2) turn brown, and hang dangling for a time; at length they fall away, leaving only the blackened stems. The roots remain generally sound to the last, but I have found red blotches upon them which caused them to rot off.

The shepherd's purse has afforded another very remarkable case of the same kind; indeed, on no plant whatever has the effect of parasitic mildew appeared more clear and self-evident than on this. It is very commonly attacked both by Botrytis parasitica and Uredo candida, but the Botrytis is by far the most powerful agent of the two. At first a few scattered plants of it appear on the stem, but in a short time a dense tuft is formed, which soon encircles them to an extent of two or three inches (Tab. B.): this part next assumes a swollen, gouty appearance, covered with the mildew as with fine hoar frost. Sometimes these parts are swollen to four times their natural size, and for a time no discolouration takes place, but as soon as the mildew has fructified and run its course, a moist, brown, gangrenous blotch invariably results to the extent of the mildew, at least, and the

upper part of the plant bends down at this point and dies, as I have endeavoured to represent, the lower portion soon following. The leaves, when attacked, turn yellow and die, and the slender pedicels suffer in the same manner as the stems, falling off and leaving the racemes nearly naked. The roots are sound at the time, and the plants previously to the attack appear in the highest state of luxuriance; not the slightest doubt therefore can exist that the mildew produces the gangrene in this case, and not the gangrene the mildew; and so far from this being a rare occurrence, it is quite the reverse; and I speak literally when I say that cartloads of such specimens might have been procured in my neighbourhood in 1848-9, and I have seen a great deal this season.

Uredo candida (B. 2) attacks the silicles as well as the stems and leaves, growing immediately beneath the epidermis, to which it gives the appearance of fine white enamel: at length this bursts, and the tumour is found to be filled with large white globular sporidia. When this completely envelopes the stems, as it frequently does, the upper part of the plant dies.

I think the cases to which I have referred, and of which I have preserved specimens, are sufficient to satisfy any impartial mind that plants even of native growth may be destroyed by the attacks of parasitic fungi, although previously in perfect health; at least they have afforded the fullest conviction to my own mind, notwithstanding at one time I entertained a contrary opinion. Many persons I know, who at one time laughed at the idea of the 'Fungus theory,' as it was termed, have entertained very different sentiments after inspecting their own vineries. Such are the ways by which the Creator of all things informs mankind that they must not despise even the least of His works, which are as beautiful and perfect in their generation as man in his.

I will now, for the sake of comparison, shortly describe the modus operandi of the Botrytis infestans (fig. 9). At first, a few plants of it appear on the underside of the leaves of the potato; beneath which a dull spot ensues, like a bruise; surrounding this spot a greyish margin is seen, and the part within assumes a darker colour; being, in fact, dead—the grey margin denoting where the *fungus is growing;* and the inner spot where it has *done its work* and passed away; and if the weather has been bright and windy not a trace of it can be found either on that or the adjoining green portion of the leaf, as it cannot live if exposed to a brisk air, but spreads rapidly in dull gloomy weather. Scattered plants may also be found on the stems, and, at times, in shaded situations even dense grey tufts are perceptible by the naked eye, beneath which the dull gangrenous blotch always ensues; which infects the circulation of the plant, and

seldom fails to destroy the foliage and stems, and more or less of the tubers.

If these also are examined carefully under a strong lens, as soon as they are dug up, even healthy looking potatoes will be found supporting scattered plants and tufts of Botrytis, as I have frequently proved by finding them myself in the above manner, and afterwards submitting them to a higher power of the microscope; and wherever this fungus grows a blotch always succeeds it. Many small white spots may be seen on new potatoes at this time, partially diseased. These spots consist of the plants of Botrytis which have fructified and fallen into a heap, closely adhering together by their glutinous surfaces. If these little tufts are moistened, innumerable spores will burst forth corresponding with those of the Botrytis, and often mixed with others, which seem to follow closely in its wake, both in the ground and after the crop is stored.

Of these, Verticillium and Dactylium are conspicuous; and Botrytis lateritia succeeds them. The fact that the Botrytis infestans will live and fructify on the tuber underground is another important link in the chain of evidence on which this question depends, and some idea of its penetrating powers may be formed from the following fact. On one occasion, when my potatoes were being dug, I noticed a greyish appearance on a portion of earth closely pressed into one of the eyes of a potato, and on submitting it to my microscope, I found it to be the Botrytis infestans, which had passed from the tuber nearly a quarter of an inch through the earth, and was fructifying on its surface.

I am of opinion that the roots or mycelium of this and similar parasites permeate the tissues of the potato and other plants to a considerable extent, without being able, under certain conditions of the plants, to protrude through their skins. In one or two instances I have had ocular demonstration that such is the fact.

Having thus shown that the Botrytis infestans is the immediate instrument whereby the potato is destroyed, I will endeavour to trace the condition of the plant from the earliest period up to the time of its attack by that fungus.

I commence with an examination of the young shoots previously to planting the sets; for in most cases they sprout in the places where they are stored; and I can state most positively that these are nearly all in a diseased state, being blotched in the same manner as the roots are found to be after they are planted. Accompanying these blotches I find a small white mildew composed of slender moniliform branched threads situate between the healthy and diseased portions. On placing thin

slices of the shoot under the microscope, I find, however, that its mycelium runs amongst the healthy tissue (Tab. C. 2). I was also greatly surprised on discovering that it was not confined to this part of the plant, but that it actually grows in comparatively large tufts on the small hairs with which these shoots are clothed (Tab. C. 3).

Many wonderful phenomena have been brought to light by means of the microscope; but I know of no botanical discovery more curious than this. I have named it Oïdium setarum. It preys upon the healthy hairs until they are exhausted, when they turn brown, and their fluid, vitiated by decomposition, is transmitted to the parts beneath. Having dug up potatoes for examination, in every stage of growth, I find the roots generally more or less diseased, and this mildew frequently upon them, but not on the tubers.

On a review of the above observations, and after a careful examination of the various specimens which I have collected, clearly displaying the insidious and predatory habits of several species of parasites, very nearly allied to that found on almost every part of the potato plant, it is obvious that the latter exhibits no sign whatever of any exemption from their power, which occasionally lays low even the denizens of the soil. On the contrary, it has suffered, as might be expected from its foreign origin and succulent nature, more severely than many of them.

Under a firm conviction that this is the case, it may not be uninteresting to inquire by what process it is probable that the gangrenous blotches on the potato and other plants are produced.

Most chemical authors attribute them to putrefaction or oxydation of the tissue of the plants; but in what way that first commences is confessedly involved in mystery. It is, however, my belief that this destructive force is set up within the plants by means of the decay of the internal filaments or roots of the mildews which vegetate on their surface. Decaying matter being thus secretly introduced among the tissues produces at first a small spot, which soon spreads iuto a blotch by contagion. That ammonia is given out abundantly during the decomposition of these fungi is certain, both from the pungent smell which they emit when enclosed in a box, and from other tests to which I have submitted them. It is the property of ammonia to turn vegetable substances brown, and such is the effect produced by the decomposition of these fungi in the juices of plants; indeed, from their gelatinous nature and the homogeneous dark mass which the parts beneath a mildewed patch ultimately present, I am of opinion that the entire substance of their internal filaments is dissolved in the sap of plants.

I have placed portions of the mildew in the sap of the plants on which it grew and also in water, both of which have a dark colour imparted to them. Not being acquainted with chemistry, I submit this view of the case to those who are proficient in that science. I think, however, that as all traces of the structure of the mildew are lost, and a brown colour imparted to the sap of the plant on which it grew, which I have more than once proved, I may reasonably conclude that a similar effect is produced naturally when the mildewed plant in a state of nature presents the same features.

That the actual disease of the potato is of a gangrenous nature is generally admitted, and in my former Essay I was of opinion that such was the primary cause of it. That gangrene is commonly produced on plants without the aid of fungi I have had abundant evidence, and I am quite confident Botrytis infestans was not present (at least externally) on those plants on which I made the experiments described in my former Essay ; and from which, owing to the limited time of sending it in, I was obliged to draw my conclusions. As almost every statement therein was the result of my own observation, I do not wish to withdraw any portion, except such matters of opinion as are at variance with the experience which I have since acquired of the power of parasitic fungi.

Close observation of these tyrants of the vegetable kingdom for the last four years has convinced me that the gangrene of the potato is produced by the mildew, Botrytis infestans, and that I was previously in error in supposing that the Botrytis was the result of the gangrene. The minute Oïdium setarum certainly does not produce the disease on the tubers, and though instances may occur of these being diseased previously to the haulm being attacked by Botrytis, I am of opinion that such cases are by no means common. No sort escapes its attack ; but with me, that called farmer's profit, has produced the largest and by far the soundest crops.

As the term "potato disease" is a very vague expression, and there is no word in common use which embraces the class of diseases which may now be fairly referred to the action of fungi, I beg to propose the name "Mycopathy" for such injuries as I have shown frequently arise from them.

I have much pleasure in thus adding my humble testimony in support of the view taken of this subject by the Rev. M. J. Berkeley, who from his previous studies was so well qualified to form a correct opinion upon it.

Cranford, August 22nd, 1850.

XXIV.—*Report on the Exhibition and Trial of Implements at the Exeter Meeting*, 1850. By Colonel Challoner.

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As the duty of furnishing a report to the Society on the Exhibition and Trial of Implements at the country show has now devolved upon the senior or retiring steward of that department, the writer of this report gladly avails himself of the resolution of Council in 1844, which determines—

> "That the person whose business it is to draw up the report on the "show of implements should do so from the different reports made "to him by the judges, and for which they are to be solely responsible; but upon any trials during which the reporter has been "present himself, it would be competent for him to make any "remarks he may think necessary."

Abiding by this wise decision of the Council, the writer will confine his observations to those trials which he attended to in his own department in the trial yard, as it is quite impossible for any steward, while attending closely to the duties which devolve upon him in his own department, to report (of his own knowledge) as to the merit or demerit of any implement on trial in another place.

Mr. Thompson, in his very able reports on the Exhibition and Trial of Implements both at York and Norwich, has so fully gone into every subject connected not only with the objects of the Society in promoting these trials, but has so well shown the gradual advancement in each succeeding year, both before and from the period, that Mr. Miles, as Senior Steward of Implements at Northampton, gave directions to the judges to bear in mind certain rules for more accurately testing steam-engines, threshing-machines, and other crank implements quite up to the more perfect and satisfactory tests as exhibited at York and Norwich, that it would be extending this report to an unnecessary length to repeat any of those observations so carefully and judiciously drawn up in the reports alluded to, further than by recording the writer's full concurrence in them, and by referring the readers of this report to those of York and Norwich for all those particulars which the experience of another year (with very few exceptions) substantially confirms.

The following Report of the Judges of the Field Implements was forwarded to the Senior Steward by the Honourable Dudley Pelham, who acted as Steward of the Field Department:—

Report on the Exhibition of Field Implements.

The land was altogether in very good condition, and much better adapted for the trial of Field Implements than is usually the case at the season in which the Society's Exhibition takes place.

Plough best adapted for general purposes.—Of this class a great variety were exhibited, and the judges selected a good many in order to allow a fair test of the different shaped, as well as different sized mould boards; the land on which they were tried was of a sandy loam, yet a little brittle from want of rain. A furrow of 5 inches was first ordered to be turned, going six times up and down the field; afterwards at the depth of 7 inches; and in the event of the work being shallower than that, the plough to be disqualified or passed unnoticed, those two depths being considered to include "general purposes." The "*Criterion plough*," invented by the exhibitor, Mr. Ball of Kettering, cut out the furrow slice in an admirable manner, and turned it properly, *i. e.* in leaving it at an angle nearly approaching 45 degrees, which is important, inasmuch as in that position the soil is better

exposed to the atmosphere, sun, &c., than at any other angle. The "Criterion" was awarded the prize in consequence of its having more nearly accomplished the requisite performances than any of its competitors.

The judges "highly commended" a plough in this class exhibited by the manufacturer, Mr. Busby, of Bedale, the soil being clearly cut and well turned, but from the situation in the field it did not maintain its position, falling in small pieces into the furrow, which was solely attributed, not to defect in the plough, but to unnatural freedom of the soil in that part of the field.

Ploughs best adapted for deep ploughing.—The trial ground was exceedingly favourable, of a strong loam, subsoil clay; in this class thirteen were set to work, with instructions to turn a furrow slice of not less than 9 inches in depth, leaving the width to the discretion of the exhibitors or their ploughmen; after a few rounds the J. A. of J. Howard and Son, of Bedford, showed its work to be superior, not only in turning the furrow slice in a complete and satisfactory manner, but in placing it in a proper position (as before mentioned), cutting out the furrow square, clean, and perfectly level.

Mr. Hensman's (No. 2) plough deserved commendation, having made fair work, cutting very cleanly, and removing the soil better than might have been anticipated from the shortness of its mould-board or furrow-turner, which, had it been a little longer, would have been a formidable competitor against the J. A. of Howard and Son.

The G. D. plough exhibited by Mr. Williams, of Bedford, accomplished its work apparently well, in turning and laying the soil smoothly and evenly, but on closer examination the work was evidently inefficient, the furrow-slice being forced or squeezed over rather than taken up and relaid in a right position, which was the more objectionable in an implement of such magnitude; the judges considered that a plough of such unusual size is not *generally useful*, and they recommend that no plough should exceed from 20 to 22 stones, however deep it may be required to plough, and would advise the use of the "subsoil" plough when a greater depth is desired.

Turnwrest ploughs.—Nine One-way or Turnwrest ploughs were tried separately under the most minute inspection, particular attention being paid to the requisite alteration at each end in turning, and the time occupied in such alteration; the decision was clear in favour of the well known plough invented by Mr. Lowcock, of Thorverston, which the judges consider next to perfection for ploughing hilly ground, and are of opinion that where such land is cultivated, being inaccessible up or down the hill, the turnwrest is invaluable, or even indispensable; the only alteration in Mr. Lowcock's plough, after arriving at the end, in

preparing for turning, is the pressing of a spring between the handles, which are turned over when the spring, being self-acting, fixes itself on the opposite end of the implement, which thus secures the handles and prepares the plough for returning along the same furrow, turning over the slice in the same direction as before; the alteration may be made in a few seconds, much less time than even two active horses would require for turning into the furrow; the draught chain, as the horses turn, slides along an iron rod to the point of draught required for returning.

R. Gray and Son of Glasgow exhibited a good specimen in this class, being simple in its alteration and good in principle, but it did not work so regularly as the one above mentioned, the price also being very great, viz., from 9*l.* to 10*l.*

Most of the others were on a bad principle, for the land-side, after alteration, had to form the turn-board, and *vice versâ;* and a good "land-side" cannot be expected to form a perfect "mould-board," nor can a well-turned "mould-board" be transformed into a straight "land-side."

Paring-ploughs.—Three paring-ploughs were thoroughly tested on Clover Ley; the very efficient manner in which the one invented and exhibited by Thomas Glover of Thrussington, near Leicester, performed the work, entitled it to the award of the prize. The sod was pared at 1 to 2 inches deep, as required. The turf thus cut was 14 inches wide. The competing ploughs were inferior, in fact inefficient.

Subsoil Pulverizers.—Ten of these were tried on the heavy land, following in the furrows turned by the heavy-land ploughs; the subsoil was free from stones, and of a texture highly favourable for the trial. For the purpose of more accurately testing the required power, the same pair of horses were employed to draw each implement; the depth directed to be stirred was 6 inches, but at that depth the horses were strained, the resistance being either beyond their power or too great for continuous work. The depth was therefore varied, according to the power required to move properly each implement, and the depth of subsoil moved was accurately measured. The observations on trial proved that Howard and Son's improved "Read's" plough worked as easily at 6 inches as others did at 3 to 5 inches: a great advantage in point of draught is derived from Mr. Howard having so arranged the draught-chain as to enable two horses to work abreast, whereas most of the others created much friction on the land side of the furrow, materially adding to the resistance offered. Another improvement is also perceived in this, that the hind part of the beam being cranked, the mortice in which the upright share is fixed is nearer the ground, which gives strength; consequently the prize was awarded to J. Howard and Son, of Bedford.

A desirable improvement was added to a subsoil pulverizer exhibited by Mr. Gray, of Glasgow, viz., a leverage by which the implement could be raised out of work at the end of the field, and the holder need not weigh out of work during the time that the horses are turning.

Heavy Harrow.—The prize was awarded to W. Williams and Co. for their Four-beamed Diagonal Harrow. They are the same as have obtained the prizes for several years past, either exhibited by Mr. Williams or by some manufacturer licensed to make them: comment is unnecessary, as they have been before explained in the Royal Agricultural Society's Journal.

Light Harrow.—The light harrows selected were tried on fresh ploughed land, as well as on that to which a turn had been given by the heavy harrows; and. although the land was in a good state for pulverization, the work produced by the implements was very different, and some of it very irregular: the decision was given in favour of J. Howard and Son's patent jointed harrows, the judges highly approving of them, and considering the harrows better calculated for working on the sides of furrows, &c., and strongly recommending them to those who have their crops sown on the narrow stetch, as they cling round the edge of the furrow, leaving it pulverized in a convex form, at the same time searching the bottom of the furrow; the joint having no tendency to work upward, they are equally applicable to level lands in the arrangement of the tines, &c.: these very much resemble those of W. Williams and Co.

Cultivator, Grubber, and Scarifier.—Of these, eight were selected out of the numerous collection in the yard, which were first tried as "grubbers" on a piece of strong clay that had been ploughed out of condition (*i. e.* in a wet state), and from drought had become baked and crusty; they were ordered to penetrate as deep as the land had been ploughed, but from the hardness and tenacity of the soil, and from the tines being ill-shaped and the manner in which they were fixed to the frames, which were altogether too light for such work, the motion and work were very irregular, scarcely proceeding 5 yards together at the same depth. The "Uley cultivator," exhibited by Mr. Crosskill, of Beverley, worked very steadily and at a regular depth, breaking the soil more than might have been anticipated from the state of the land: from such performance the judges highly commend the "Uley." The cultivator exhibited by the inventors, Smith and Co., of Stamford, is on a good principle, but, from its lightness, did not perform this work so well as the "Uley," although the tines are equally well constructed and arranged. After the whole were satisfactorily tested they were removed to a clover ley, which was in a stiff state, to try their merits as "scarifiers." Out of the number, only two were considered of any service in this respect;

some of the implements being immediately withdrawn, after proceeding a few yards, others being persevered with, without succeeding in effecting the purpose for which they were intended. Crosskill's and Smith's again contended very evenly, and worked admirably: after a fair contest the decision was given in favour of Smith and Co's, it having an advantage in the side levers for raising or lowering the implement to suit uneven surfaces, and the action of the fore-wheels is superior, equalizing the pressure on sidelong ground.* It is the opinion of the judges that had "Biddell's scarifier" been exhibited, a well contested race would have been the result.

Pair-horse Scarifier.—In this class five were selected for trial on the light land, from the hardness of the surface and the requisite lightness of a pair-horse implement. The work was, on the whole, inefficiently performed: the preference was given and the prize awarded to Edward Bentall's, of Maldon; but the judges are of opinion that there is no such implement as a good "two-horse scarifier," because for use with a pair of horses the implement must be made so light, that it fails to do the work required with any degree of accuracy, and they would, therefore, prefer skim ploughs: † some were noticed in the show-yard—good in their construction, and well calculated to accomplish the work of a scarifier with much greater precision and facility than a "pair-horse" one, particularly when the surface is dry, which is generally the case when that operation is requisite. The judges would further suggest that two occupiers of *small* farms might purchase a four-horse scarifier between them, costing each party no more than if each had a two-horse one; and thus, in whatever state the land might be, they would have their work done effectually.

Horse-Hoe on the Ridge.—A great variety of this class were exhibited, out of which ten were ordered out for trial. The land was in good order, but the turnips being irregularly drilled, could not be hoed so well as they should have been. Mr. Busby's made the best work, and was very much approved of, from the form of the knives or hoes: the advance or front hoe in shape

* There is a great advantage in the two wheels with the *double action* in the axle with which this implement, as well as that first exhibited by Mr. Smith at the Norwich meeting, is fitted; and I am of opinion that these and similar implements, such as Norwegian harrows, &c., would be improved by the general adoption of this plan. On rough and uneven ground, or in crossing furrows, the single wheel often fails to be of service, and is frequently an absolute *impediment*, which is not the case with the fitting introduced by Mr. Smith, who has also improved this implement since last year by an alteration that allows the tines to be changed, as to position on the frame, and thus the *sidelong tendency* these implements have on uneven and hard ground is much abated; having brought this defect to his notice last year, I think it due to Mr. Smith to acknowledge his prompt attention to the matter, and well to call the attention of implement-makers to these points.—Dudley Pelham.

† Some valuable information on this point is contained in Mr. Thompson's report of the exhibition of Implements at York, pp. 18, 19, 20.—C. B. Challoner.

much resembled the letter D, which is proved to be better calculated to cut weeds and roots than the triangular one: the little Norwegian harrow attached to it is serviceable. Edward Hill, of Brierley Hill, Stafford, exhibited a good mode of expansion and contraction in his horse-hoe, so that the implement can be altered at pleasure *when in motion* by a scissor action, which is given by the handles; for which invention a silver medal was awarded. The judges "commended" Garrett's ridge-hoe, as it cut the weeds and worked with accuracy, but small hoes are preferable.

Horse Seed-Dibblers.—Mr. Newberry's was the only one of this kind exhibited, and from the very high price of the implement compared to its utility, the prize was withheld.

Barrow Hand-Drill.—One of Mr. Garrett's was (amongst the few selected for trial) a superior machine, calculated to work on the ridge or flat, drilling the seeds at from 16 to 30 inches intervals. The construction and workmanship make it one of the best little machines of its kind yet produced, and one of great utility to the small farmer.

Norwegian Harrows.—The ground on which the four selected for trial were well tested was a strong hard-baked clay, on which grubbers had previously been used. From the state of the land, the strength as well as the capabilities of the implements were fairly proved. Three of these were on a square spindle, the whole of the rowels revolving at one time, which was of great service in breaking the clods more effectually than that on the round spindle exhibited by Mr. Crosskill, but for the liability to breakage or derangement, to which the former are subject, particularly in stony land, from stones being seized by the rowels, in which case something must yield or break, or the rotary motion of the whole line of rowels cease and push the clods before them instead of breaking them, which is obviated in the round spindle. For this reason it is preferable; and although no prize is offered by the Society, the judges "highly commended" the one exhibited by the manufacturer, Mr. Crosskill.*

Clod-Crushers.—Although no prize was offered for this class of implement, two were put to trial—one, manufactured by Messrs. Tuxford, of Boston, Lincolnshire; the other, by Mr. Crosskill of Beverley. The former appeared to have the advantage in pulverising an uneven surface, furrow sides, &c.;† but,

* On very tough, hard ground the Norwegian harrow is more effectual: it tosses or lightens up the clods better in breaking them, particularly if they are not quite dry, and does its work quicker than the clod-crusher, which seems best calculated for following the Norwegian harrow in such a state of the soil, and for rolling young crops. —DUDLEY PELHAM.

† This implement is of peculiar construction, being, as the exhibitor termed it, vertebral or jointed; in place of having an ordinary spindle, the rings are so connected as to work independently, and to rise or fall with the undulation of the land, weighted levers being superadded to guard against the obvious tendency of such an arrangement, viz., failing to crush the obstacles it meets with.—DUDLEY PELHAM.

from their blunt formation, the teeth did not enter the ground very well. After a lengthened trial, it was clear that Mr. Crosskill's, which worked in its usual masterly style, was the best, and the judges testified their opinion by "highly commending" it.

Drain-Ploughs.—A novel implement of its character was exhibited by Mr. John Fowler, of Melksham, Wilts, manufactured by Messrs. Ransome and May, which was set to work on the strong land (as a mole-plough), cutting the drain in a clay subsoil 2 feet 6 inches deep, and placing, or rather drawing, the wooden pipes which were previously manufactured by Mr. Fowler's "pipe-making machine." Manual power was first applied to the "windlass," by which means the plough travelled at the rate of 2 yards per minute; two horses were then attached, and it worked at the rate of 3 yards per minute for a short time, when the cogs of the wheels gave way, which were evidently too slight for the power required to draw the implement. During the trial, however, the motion was remarkably steady, although several stones came in contact with the plough, one of which was ascertained to have been severed in two. The performance was far better than was anticipated, taking into consideration the stiffness of the soil and subsoil; yet the application (until further improvement) should be confined perhaps more particularly, as was the principal intention of the inventor, to bog lands, marshes, &c., in which he proposes to use a twisted straw or heather rope, a specimen of which he produced. To the plough and the machinery connected therewith the judges awarded a silver medal.*

A gutter-plough was exhibited by Mr. Thomas Moore, of Exeter, Devon, which the judges "commended," it having on trial cut out well small trenches or gutters, preparing the land for irrigation, or for the purpose of carrying off the water from low undrained land.

The only drain-plough exhibited for the prize offered by Mr. Slaney was Mr. Comins', of South Molton; and from its inefficient manner of performing the work, the judges thought it right to withhold the prize.

Drill for general purposes.—In reporting upon this drill, it appears almost invidious to make comparisons between the un-

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* The inventor states that the price given in the catalogue far exceeds what it can be supplied at in future, the implement having been only completed just before the meeting; from the same cause the working of all the machinery appeared to be less good than might reasonably be expected under more favourable circumstances. It should be explained that the designer's plan of having wooden pipes is for the purpose of making use of refuse timber on an estate, the saw-bench being generally useful, and the waste wood, left after forming the pipes, being sold as firewood. Mr. Fowler stated that the cost of the pipes was extremely low as compared with all others, though I forbear to quote his figures; they fit into each other, a slit being cut in them for the admission of the water after the ends may, from swelling, have become tight. They are strung on a small rope, by which they are drawn after the plough whilst in motion. It is an ingenious invention, well deserving notice.—Dudley Pelham.

rivalled productions of Messrs. Garrett and Hornsby; and from the fact of Messrs. Hornsby having carried the palm six years out of nine, no higher commendation can be appended to their implement. Nevertheless, Messrs. Garrett's drill was of equal workmanship, and its work was performed with equal precision in every respect. The judges awarded them the prize, in accordance with their instructions, there being so great a difference in favour of Messrs. Garrett's in the price, which justly entitles their drill to the approbation of the Society.

Pair-Horse Steerage-Drill.—This drill, which is probably more used than any other, received the judges' particular attention both in respect to its construction and its general adaptation to the varied surface of country over which it must work. Although there were several excellent drills competing in this class, amongst which we might mention Messrs. Garrett's, and that from the old-established manufactory of Mr. Jas. Smyth of Peasenhall, yet Messrs. Hornsby, by the introduction of a rack and pinion-wheel to sustain the steerage over rough stony ground, and of their vulcanized Indian rubber tubes instead of tin, defending the seed from wet and wind in open districts, and having other advantages, and by the addition of their double coulter-bar, giving an equal leverage to the coulters without any change of weights, and thus necessarily ensuring an uniform depth to the seed, the prize was awarded to them; also a medal for the vulcanized Indian rubber tubes, and the improvement in the steerage.

Drill for small occupations.—This prize was awarded to Messrs. Garrett for their seven-row corn and seed drill, with room to add two more coulters if required. It is a *fac simile* of their other corn drills, and from its cheapness and workmanship it merits the attention of those farmers for whose use the Society demanded it.

The best Turnip-Drill on the Flat.—This drill, to which the Society directs especial attention as to its capability of drilling large quantities of rough or other manures, was put to a severe test. That of Mr. Jas. Smyth drilled the largest quantity of rough compost best, but in many respects did not equal some of the others. Messrs. Hornsby's drilled large and small quantities in a very perfect manner; and from the openness of its construction enabling the drillman to detect and remedy any stoppage in the delivery of manure, having, too, the advantage of their other improvements before mentioned, the prize was awarded to it.

Turnip-Drill on the Ridge.—This drill, from having fought so many well-contested battles, received an extra share of the judges' attention, who, in awarding the prize to Messrs. Hornsby, wish to congratulate them upon having made great improvements since last year. These consist principally in having the rollers made in sections, adapting them to any ridge, from 2 to 3 feet, and the

wheels shifting to correspond, with cranked axletrees, bringing the large rollers in a line with the wheels, lessening the draught, and assisting the leverage in raising them at the land's end, and being able to weight the scrapers when required; also combining the efficiency of former years, we consider this drill more perfect than any hitherto produced.

The best Drop-Drill.—This prize was again merited by Messrs. Garrett; and considering the simplicity of their eccentric motion, with connecting-rods to the pipes, the seed and manure are delivered with great exactness, and no part seems liable to get out of order. The different appliances are easily removed, and it is easily converted into a common manure and turnip drill, thus combining the two without either difficulty or trouble. But the advantage of having the seed in bunches instead of rows, in places where dibbling has been longest practised, is considered rather mechanical than otherwise in preventing wire-worm and other insects working so freely from plant to plant. The objection to drop-drills seems to be the depositing so much manure and seed in so small a space. Any larger quantity of manure, put directly under the plant, than is necessary to bring it through its first stage, can hardly be so beneficial as if more widely distributed, provided it be within the space required for the full development of the plant.

The Manure Distributor.—The requirements of this implement appear to be misunderstood by some of the manufacturers, as out of six tried only one covered a sufficient breadth to compensate for the difference between horse and manual power. Those of Messrs. Garrett and Hornsby were wrong in principle, dusting the manure up into the air instead of quietly distributing it upon the ground. It must be borne in mind that all artificial manures ought to be perfectly prepared for sowing before being put into the machine, and should not be left for the machine to prepare. The method of sowing was in most instances the same as the manure-drills; but Mr. Holmes's having the required width, and a simple contrivance of the receiving-board for sowing either in drills, on ridged or flat work, or broadcast, and with a good delivery, we considered him entitled to the prize. On trial it sowed guano mixed with chaff well, as also rougher manure.*

* The improvements already made in the manure distributors, independently of other considerations relative to the scientific and practical reasons which should guide us in our application of manures for indirect effect upon the soil, or for the more immediate purpose of the plant, seem to suggest the probability of the practice soon becoming more general of employing separate machines for sowing seeds and manures, presenting the advantages of having lighter, simpler, and cheaper implements, with the consequent result of the operations being performed quicker and with greater precision. Some of the judges concur with me in this opinion. The best drills having now become such excellent machines by the successive improvements introduced by

A patent hand-implement of this class, invented by Dr. Newington, and manufactured by Dufaur and Co., appears to possess the desideratum of sowing small quantities of potent manures without the necessity of mixing other substances to increase the bulk without adding to their efficiency. This machine, like some of its larger competitors, was considered not wide enough, only covering four feet, and the price too high. The manufacturers undertook to make it six feet wide, to heighten the wheels six inches (and of course the notched wheels which drive the oscillating rod), and to reduce the price to 4*l.* With this understanding, the Judges confidently commend it to the notice of agriculturists, as being the most economical and perfect method of top-dressing corn or grass-land yet brought out.

Liquid Manure Distributors.—The machine to which the prize was awarded was tried with liquid, puddled with cinder-dirt and straw-chaff, which it delivered with ease and regularity, except on sidelong ground where an additional number of partitions were required to prevent the liquid running too much to one end of the troughs. This Messrs. Robert and Reeves saw, and are about to remedy, which will render it far superior to any hitherto in use.*

The Judges also "highly commended" their Liquid Drop-Drill, made upon the same principle, which delivered the seed and liquid both in a continuous stream, and at intervals very correctly. This implement is gaining favour very much with a view to securing a plant of turnips in dry weather, where other methods fail.

Horse-Hoe on the Flat.—The Messrs. Garrett, as usual, stand unrivalled at present in the manufacture of this implement, and received the prize.

The Judges, however, "commended" the horse-hoe of Mr. Smith of Kettering, stand 61, art. 2, as a cheap, efficient implement, and coming within the reach of small farmers; it is a desirable adjunct in this department of culture.

Corn Mills for Fine Meal.—The Judges regret that circumstances over which they had no control prevented their trying more than three of the mills which they had selected: that of

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the enterprising exhibitors, it is to be hoped that the attention of implement-makers will be successfully directed to the formation of manure-distributors best capable of sowing in rows or broadcast the smallest quantities of fine artificial manures, as well as larger quantities of rough manure. In many of these implements the delivery is not low enough for fine manures, which are easily blown aside by the wind.—Dudley Pelham.

* The exhibitors of this liquid manure distributor deserve both praise and encouragement for the prompt and able manner in which they have carried out the suggestion made to them at Norwich; and when a few minor improvements in detail have been made they will have produced a most useful and efficient implement. I regret I did not call their attention to the probability of the iron buckets corroding from the saline particles in some liquid manures, and whether they might not substitute galvanized iron or some substance not liable to corrode.—C. B. Challoner.

Messrs. Clayton and Shuttleworth ground at the rate of eight bushels per hour, at nearly five horse power; that of Mr. Hayes seven bushels and two pecks, at six horse power. The quality of the work was equal; the prize was awarded to the former.

T. P. Outhwaite.
Thomas Scott.

The following Report of the Judges of the Miscellaneous Department was forwarded to the Senior Steward by Sir Matthew White Ridley, Bart., who acted as Steward of the Miscellaneous Implements:—

Report on Miscellaneous Implements.

Linseed and Corn Crushers.—We selected four crushers belonging to Messrs. Wood, Stanley, Garrett, and Whitmer. From the results of the trials made by us of these machines there did not appear much difference in their work, but the power required was so much in favour of Mr. Stanley's, stand 64, art. 5, that we gave him the prize. Below we give a tabular statement of the trials:—

Exhibitors' Names.	Stand.	Art.	Price.			Comparative Amount of Power required.	
			£.	s.	d.		
Wood . . .	29	1	12	12	0	3808	Crushed rather the best.
Stanley . . .	64	5	12	0	0	2666	
Garrett . . .	76	25	11	0	0	3267	
Whitmer . . .	96	1	10	10	0	4323	

Chaff-Cutters.—We selected seven of these machines for trial. The result we give below:—

Exhibitors' Names.	Stand.	Art.	Price.			Chaff Cut.	Weight on Lever.	Number of Turns of the Testing Machine	Units of Power used.	Comparative Amount of Power in Units that would be required to cut 112 lbs. of Chaff.
			£.	s.	d.	lbs.	lbs.			
Smith & Co.	62	7	14	[illegible]	0	34	21	295	6,195	20,407
Richmond & Chandler	24	4	14	[illegible]	0	40	40	296	11,840	33,152
Garrett . .	76	23	14	[illegible]	0	42	42	266	11,172	29,792
Cornes . .	72	1	14	[illegible]	0	40½	32	261	8,352	23,096
Williams .	28	6	10	10	0	39½	28	294	8,232	23,341
Cornes, jun. .	20	8	14	0	0	42	25	315	7,875	21,000
Gillett . .	13	1	7	7	0		22	188	4,146	

There was some improvement in the arrangement for working these machines, but none of sufficient importance to comment upon. We found the work performed by Cornes's, stand 72, art. 1, the best, and although the power required to drive his machine was somewhat more than for Smith's, we came to the conclusion to give the prize to him. These machines were all tried in cutting chaff 3-8ths of an inch in length.

Turnip-Cutters:—

Proprietors' Names.	Stand.	Art.	Price.	Comparative Amount of Power required.	
			£. s. d.		
Phillips . . .	1	2	5 15 0	1786	Cut very well for sheep. Cut badly for beasts.
Samuelson . .	25	2	5 10 0	1660	Did its work remarkably well for beasts and sheep.

In making our decision upon the merits of these machines, the only two we selected for trial, we gave the prize to Mr. Samuelson, the successor of the late Mr. Gardner, for the very excellent manner it cut both for beasts and sheep. Phillips's implement did not cut so well for beasts, but he has much improved it for sheep since last year.

Oilcake-Crushers:—

Proprietors' Names.	Stand.	Art.	Price.	Comparative Amount of Power required.	
			£. s. d.		
Samuelson . .	25	20	6 15 0	2308	Crushed very well, but required too much power.
Nicholson . .	92	3	5 5 0	1182	Did its work very well.
Garrett . . .	76	26	9 9 0	1610	Worked badly.

In this class of implements we consider that the one exhibited by Mr. Nicholson, stand 92, art. 3, had so much the advantage, both in the power required and price, that we awarded him the prize.

Steaming Apparatus.—We awarded the prize to Mr. Stanley, stand 64, art. 3. The merit of this apparatus is so well known that it requires no comment from us.

One-Horse Carts.—We awarded the prize to Mr. Busby, stand 18, art. 17. This cart is similar in principle to the one shown last year, its wheels being on the cylindrical principle, easily to be

filled by the labourer and easily repaired when it becomes necessary. In this cart the wooden nave is retained.

Waggons.—We have nothing to add on the merits of this implement, being precisely the same as in the one shown last year by Mr. Crosskill, to whom we have again awarded the prize.

Draining Tools.—We awarded the prize to Messrs. Maplebeck and Lowe, Stand 89, art. 42.

Horse-Rakes.—We selected three of these implements for trial. Mr. Williams's rake, Stand 28, art. 5: this machine did not make quite clean work when the rake was full, but otherwise did its work very well. Messrs. Smith's, Stand 62, art. 2, did its work very well. Messrs. Holmes's, Stand 34, art. 14, did not work well. Messrs. Howard's, Stand 10, art. 26, performed its work exceedingly well, raking clean when full, littering none, and being best in hand. We awarded them the prize.

Haymaking Machines.—We only selected two for trial. We have awarded the prize to Messrs. Smith, Stand 62, art. 1. The superior merits of this machine entitled them to it. Messrs. Barrett and Exall's, Stand 39, art. 12, performed its work very well, but we considered too much time was lost in adjusting it in reversing its action.

Cottage Stove.—We awarded this prize to Messrs. Nicholson Stand 92, art. 7.

Cider Mills.—We regret exceedingly we could not make trial of these implements, in consequence of not being able to procure apples for that purpose. We recommend them to be tried at some future time.

We recommended the following articles for medals:—Mr. Samuelson's churn, Stand 25, art. 17; Nicholson's stove, Stand 92, art. 15; Read's agricultural fire-engine, Stand 58, art. 3; Crosskill's railway, Stand 4, art. 61, 62, 63, highly approving of all as worthy of the medals awarded.

The following implements and articles in the Miscellaneous Department deserved our special notice:—Smith's gravel screening apparatus, Stand 104, art. 1; Barnard and Bishop's iron-fencing and gates, Stand 69, art. 28 and 29; Read's veterinary syringe, Stand 58, art. 5; Weir's union joint for connecting hose-pipes, Stand 16, art. 7. Crosskill's root-washer deserves our praise for its usefulness for that purpose; nor must we forge, to notice the extensive stand of seeds and roots of Gibbs and Co. Stand 112; and we consider No. 19, Stand 34, a turnip and mangold wurzel-cutter, by Messrs. Holmes of Norwich, worthy of the attention of small occupiers. It cuts well both for beasts and sheep, and the price is very moderate.

James Hall Nalder.
Jno. Overell.

It is regretted that the exhibitors have not turned their attention to producing a portable and not expensive arrangement for sheltering sheep in the field, and feeding them under cover, adapted to uneven as well as level ground, as recommended in the Report on the Exhibition of Implements at the Norwich Meeting of 1849. In framing any such arrangement, consideration should be had both for sheep standing dry, and for the economical collection of all manure made by them when under cover.

M. W. Ridley.

Report of the Engineer-Judges of Agricultural Machinery.

Considering the great distance of the city of Exeter from the counties most famed for the production of agricultural machinery, we were agreeably surprised to find so many steam-engines in the trial yard, and were pleased to remark a great improvement in their general character since the Exhibition at Norwich last year, which will also be found to be maintained by the very satisfactory results produced on the practical trial with the dynamometer; but there is a very important question arises, as to how far it is desirable to increase the weight of a portable farm engine by adding to the size of the boiler; the larger the boiler, "within certain limits," if well designed, the less will be the consumption of fuel per horse power per hour; but the most economical engine in work may be in weight and price the least suited to a farmer's purpose; and as these engines are only required for a limited period during the year, it is questionable whether lightness and portability should not be deemed of great moment in guiding the decision of the judges, lest by a too exclusive adherence to the dynamometrical test a class of engines should be introduced for trial expensively constructed and of too large a size, indeed, not made for general sale among agriculturists, but merely for the purpose of winning the race and carrying off the prize at the annual exhibitions of the Society by consuming so many lbs. less of coal per hour, the price stated in the catalogue being inconsistent with the production, with a fair profit, to the maker of such expensive engines. To guard in future against this, we would suggest, that each engine entered for trial should be of the same nominal power—say six-horse, and that the entire weight of each engine to be worked at that power should not exceed 55 cwt., a certificate being produced of the weight of each engine from the weighing-machine most convenient to pass over in proceeding to the trial-yard. We would also suggest that it would be desirable to place a proper person in the trial-yard, under the direction of the stewards or

director of the show, to enforce obedience to regulations necessary to enable the judges to go through their duties with comfort, and to guard them from improper interference in the discharge of the same. We would make one observation more, that we feel in duty bound to express an opinion that there is greater security, as to quality of work and durability, to the farmer in purchasing an engine direct from the manufacturers.

At the end of the remarks which we now proceed to make on each engine separately, will be found a tabular statement of the results arrived at through the dynamometer. The following eight engines were submitted to trial:—

Stand 12, art. 1.—A four-horse portable engine, manufactured by George Howe, Southwark, London, but exhibited by Dean, Dray, and Dean, London. The workmanship of this engine was fair but not first-rate, crank and eccentric being of cast-iron, which is objectionable; slide-bars strong and well arranged; connecting-rod and crank-shaft of good length and well secured to boiler, which is peculiarly constructed, having two lateral openings at the commencement of and immediately above the fire-bars, into each of which are fitted three tubes, traversing the entire length of the boiler and opening into the smoke-box at the end; the force-pump has to lift its water, and forces through a heated chamber at the root of the chimney into the boiler. This engine performed its work well and economically as regards fuel, but the price, 200*l.*, being 50*l.* per horse, is much too high as compared with the better class of engines exhibited by other parties; nevertheless, we could not pass it by without commendation.

Stand 30, art. 1.—A four-horse power portable engine, manufactured and exhibited by W. C. Cambridge, of Lavington Iron Works, Cathay, near Bristol. The steam in this engine could not be raised higher than 44 lbs. per square inch, 45 lbs. being the Society's standard, and to attain to this pressure required 1¾ hours. The slackness of draft we attributed to the funnel passing horizontally along the boiler and then rising perpendicularly from over the fire-box, an exceedingly bad arrangement, showing, together with the very inferior workmanship of both boiler and engine, how very little the exhibitor could have been aware of the class of engines he would be brought into competition with; the duty performed being also at nearly four times the cost in fuel as compared with the prize engines, while the price per horse power is considerably more.

Stand 5, art. 3.—A seven-horse portable engine, manufactured and exhibited by Clayton, Shuttleworth, and Co., Lincoln. Workmanship of this engine very good and arrangement of working parts simple, the whole mounted on strong wooden

wheels well constructed; the force-pump delivers through a pipe passing inside the boiler, traversing its entire length and delivering its feed at the smoke-box end. This arrangement we think bad and inconvenient, for although the pump-pipe is felted and enclosed in an outer casing 5 inches in diameter, which also serves for the exhaust, there will be some little condensation of steam take place; moreover, the outer pipe occupies a considerable portion of the steam-room of the boiler, and the pump-pipe, in case of repair, is difficult to get at: the bearing carrying the end of the slide-bars we think has not sufficient hold on the boiler, as it only covers about 5 inches square at the part where it is bolted. The force-pump of this engine has to lift its water between 5 and 6 feet, which would be better avoided if the general arrangement of the engine would have permitted. The plates in the fire-box of this engine had been ground up to a face previous to painting, and the body of the boiler coated with vermilion and varnished—expenses, we think, quite superfluous to incur when exhibiting an engine destined for the farm-yard. The duty done by this engine will be seen by reference to the tabular statement to have been very good, there being only one other in the trial-yard, "Hornsby and Son's," which excelled it in this respect. But as we also thought that engine stronger and more durable in the working parts, we awarded to Clayton, Shuttleworth, and Co. the second prize of 25*l.*

Stand 101, art. 1.—A six-horse portable double-cylinder engine, manufactured by Wm. Butlin of Northampton, and exhibited by Hodge and Batley, 9, Adam-street, Adelphi, London. The workmanship of this engine was moderate, the cylinders on the oscillating principle—a complication unnecessary in this class of engines. The duty done by this engine, for amount of fuel consumed, was less than any other in the trial-yard, with one exception, which sufficiently stamps its comparative merits.

Stand 8, art. 9.—A nine-horse portable engine, manufactured and exhibited by Hornsby and Son, Spittlegate, Lincoln. Workmanship of this engine is good, and boiler strong; the cylinder is placed in the steam-chamber of the fire-box—an arrangement which gives an unsightly appearance to the boiler. We found the detail of this engine to have been most carefully considered, and every arrangement made to facilitate repairs when necessary. The oil-cups were on a very good and efficient principle, and the registered apparatus for heating the water previous to its being forced into the boiler we considered very good. The crank-shaft and its bearings were made for wear, exceedingly strong and firm, which remark will apply also to all the working parts, forming as a whole an engine well suited to farm purposes (size excepted, a nine-horse being, we think, too large). The duty

done for amount of coal consumed placed this engine a shade above every other in the yard, while the price and weight per horse-power was similar to its competitor, so that we considered its collective merits worthy of the first prize of 50*l.*, which was awarded accordingly.*

Stand 39, art. 43.—A seven-horse portable engine, manufactured and exhibited by Barrett, Exall, and Andrews, Reading. Workmanship of this engine moderate; time getting up steam comparatively long. There was a mistake in the lock of the wheel, which came in contact with the fly; but the performance of the engine was good, and consumption of fuel small, which we thought rendered it worthy of commendation.

Stand 94, art. 1.—A six-horse portable engine, manufactured and exhibited by Tuxford and Sons. The boiler of this engine was small and compact, but we think liable to prime, the water spaces being contracted. The general workmanship is good, and there is a novelty presented in this engine, the cylinder being placed in a box formed at the end of the boiler, with doors to lock the whole up, leaving only the ends of the crank-shaft projecting outside, through holes cut in the box. There are several very delicate mechanical arrangements resulting from the working of the engine in the small space comprised in the box, which we fear might require a little more care in the engineer while working the same than might at all times be found in agricultural districts. We think the enclosing the cylinder and working parts of the engine a decided advantage, and we have pleasure in giving our testimony to this engine performing her work well and with a moderate consumption of fuel. The wheels were of iron, which we think objectionable for farm roads.

Stand 76, art. 22.—A six-horse portable engine, manufactured and exhibited by Garrett and Son, Leiston, Suffolk. The workmanship of this engine and boiler is very good, and its general arrangement of parts such as to insure many advantages. The crank-shaft is of good length, very strong, and is placed at the extreme end of the boiler, to which the bearings are very firmly fixed, the cylinder being securely fastened on the side close to the fire box, thereby obtaining a long connecting-rod which we consider more desirable than a short one, the force-pump is attached to a cold water cistern placed under the crank shaft, from which it is worked, and is so arranged that the foot valve is below the water in the cistern, thereby insuring an unfailing action of the pump—a point gained which is second to none in importance, and an arrangement which neither of the prize engines possessed, having to lift their water from the

* We took this nine-horse to weigh 4 tons, and Clayton's seven-horse 3 tons, but the weight of each engine ought in future to be ascertained.

ground. All the working parts of this engine are brought so low that they are easily reached, oiled, and adjusted from the ground; indeed we were so pleased with its strength and portability, being a light load for two horses, and thinking it so suitable to the purpose for which it was designed, that had it not been for the superior duty done by the larger boilers of the prize engines (though in economy of time and coal used in getting up steam this engine excelled them both) we should have placed it in the front rank, but can only now highly commend.

TABULAR STATEMENT OF RESULTS.

Stand and Number.	Time getting up Steam.	Nominal Horse-power.	Coal used in getting up Steam.	Coal burnt per Hour.	Coal burnt per Horse-power per Hour.	Exhibitors and Manufacturers.
	min.		lbs.	lbs.	lbs.	
12 A 1	40	4	52½	41½	9·75	Dean, Dray, and Dean, manufactured by Geo. Howe.
30 A 1	105	4	60	112	28·00	Wm. Cambridge.
5 A 3	43	7	36½	54½	7·77	Clayton, Shuttleworth, & Co.
101 A 1	85	6	64	83	13·85	Hodge and Batley, manufactured by Wm. Butlin.
8 A 9	39	9	42	68	7·56	Hornsby and Son.
39 A 43	81	7	49¼	74	10·55	Barrett, Exall, and Andrewes.
94 A 1	90	6	44	66½	11·06	Tuxford and Son.
76 A 22	34	6	34	62	11·29	Garrett and Son.

CHARLES JOHN CARR.
WILLIAM OWEN.

Judges' Report of Threshing-Machines.—We have to report that the Machines exhibited at this meeting were many of them much improved in workmanship and in lightness of draught, as will be seen by comparing the following Table with the results of last year.

We hope that the above tabular statements, showing the results of the threshing-machines, are so far complete that they will be understood without any further explanation. The public, however, must not place reliance on the column of prices, as some exhibitors include many necessaries that others do not include; and as the cost of an implement influences the judges in their decisions, we hope the Society will in future require a complete detail of articles furnished for the price entered in the catalogue. We beg to call the attention of those exhibitors who use close drums, with the beaters in some instances not projecting more than half an inch. We are afraid that machines so constructed are very likely to be broken by stones or sticks passing between the drum and the concave. We consider it a great reflection on the agricultural interest, that while machinery, in

EXPERIMENTS IN THRESHING WHEAT.

			Specifications furnished by Exhibitors.					Results furnished by Amos's Testing Machine.											
										Horses' Power required to drive the Machines empty.						20 supposed to represent perfect Works.			
1. Stand.	2. Article.	3. NAMES.	4. Nominal Horse-power.	5. Revolutions of Horse, per Minute.	6. Diameter of Horse-walk, in feet.	7. Speed of Horse in Miles, per Hour.	8. Revolutions of Drum.	9. Revolutions of Horse-wheel, per Minute.	10. Speed of Horse in Miles, per Hour.	11. The whole Machine.	12. The Barn-Works.	13. The Horse-Works	14. Time of threshing 100 Sheaves of Wheat. m. s	15. Horses' Power required to work the Machine.	16. Horses' Power that would be required to thresh 100 Sheaves in one Minute.	17. Clean threshed.	18. State of Straw.	19. Broken Corn.	20. Total Numerical Estimate of Excellence.
46	1	Tucker . . .	4	$3\frac{3}{4}$	18	2·14	936	3·677	2·36	·89	·77	·12	3 45	5·97	22·38	19	18	17	54
76	18	Garrett . . .	4	$2\frac{3}{4}$	$21\frac{1}{2}$	2·10	712	2·439	1·87	1·39	1·34	·5	3 18	6·34	20·92	20	20	16	56
53	1	Mackelcan . .	4	$2\frac{2}{3}$	20	1·90	800	4·492	3·20	2·34	2·16	·18	3 14	10·99	35·53	19	17	18	54
4	71	Crosskill . .	4	$2\frac{3}{4}$	24	2·35	840	2·700	2·31	·83	·74	·09	3 16	5·12	16·72	19	19	18	56
81	7	Hensman . .	4	$2\frac{1}{4}$	24	1·92	1000	2·390	2·05	1·39	1·32	·07	3 1	4·73	14·26	19	20	20	59
8	11	Hornsby . .	4	$2\frac{3}{4}$	24	2·35	900	2·890	2·47	2·81	2·77	·04	2 50	8·61	24·39	20	19	17	56
20	1	Cornes . . .	4	..	24	..	1100	2·709	2·32	..	1·05	..	3 51	3·82	14·70	19	19	20	58
31	1	Holmes . . .	..	..	24	..	1020	2·583	2·21	..	2·04	..	2 6	7·16	15·03	15	19	20	54
30	2	Cambridge . .	..	..	24	..	1080	3·276	2·80	..	2·82	..	2 46	7·59	20·99	17	18	19	54
39	41	Exall & Andrewes Barrett.	4	..	24	..	1000	2·832	2·42	..	1·80	..	3 $13\frac{1}{2}$	6·21	20·02	20	19	17	56
105	7	Smith . . .	4	..	24	..	712	2·761	2·36	..	2·25	..	3 1	7·19	21·68	15	19	16	50
76	21	Garrett . . .	..	..	24	..	1000	3·302	2·83	..	3·06	..	2 4	8·42	17·40	20	19	16	55
5	6	Clayton & Co. .	..	..	24	..	950	2·229	1·91	..	4·57	..	5 40	6·36	36·04	19	20	16	55
79	1	Goucher . . .	4	..	21	..	1000	3·274	2·45	2·71	2·11	·60	2 50	8·48	24·02	20	19	17	55
31	2	Holmes . . .	6	$2\frac{3}{4}$	20	1·96	900	4·175	2·95	3·23	3·14	·09	4 14	5·22	22·09	17	19	18	54
76	20	Garrett . . .	2	$2\frac{3}{4}$	19	1·86	870	3·685	2·09	·71	·65	·06	4 5	4·16	16·98	20	20	17	57
53	2	Mackelcan . .	2	$2\frac{3}{4}$	19	1·86	1000	3·220	2·18	·76	·69	·07	5 0	3·56	17·80	19	17	18	54
39	34 or 35	Exall & Andrewes Barrett.	3	..	21	..	960	4·003	3·00	·90	·66	·24	4 16	4·12	17·57	19	17	20	56

various manufactures, performs the most delicate operations and produces the most exquisite fabrics, the comparatively rough operation of threshing corn and perfectly dressing it has not yet been accomplished, or machines for that purpose encouraged by the Society. We would also call the attention of the Stewards and Council to the desirableness of giving a prize to fixed threshing machines with dressing apparatus attached, and also to fixed steam-engines. There is one decided advantage in a fixed engine, that it will cost the farmer less in the first instance than a portable one, very much less for repairs, and we are given to understand that the construction of the boiler can be simplified and made upon a more durable plan, when weight is not objectionable, as it would be in the portable engine.

Experiments in Threshing Barley.

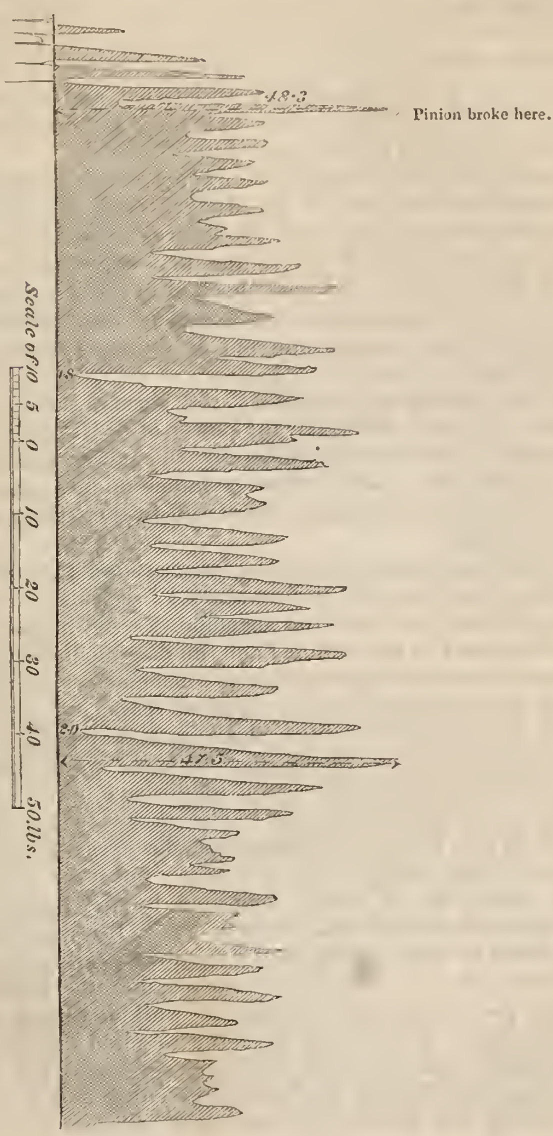
1.	2.	3.	4.	5.	6.	7.
			20 representing perfect Work.			Horses' Power required to thresh 50 Sheaves of Barley in one Minute.
Stand.	Article.	Name.	Clean Threshed.	State of Straw.	State of Corn.	
81	7	Hensman . . .	20	..	19	18·00
76	20	Garrett	20	..	18	21·48

A Two-horse Threshing-Machine, belonging to Mr. Garrett.—This machine was first tried in threshing wheat. It threshed 100 sheaves in 4 minutes and 5 seconds; the power required to work it, as indicated by the diagram of the testing machine, averaged 28·39 lbs., being equal to 4·16 horses. This power, multiplied by the *time* in *minutes,* equal to 16·98 horses to thresh 100 sheaves of wheat in one minute.

The power required to work the machine empty was then tested, and it was found to take ·71 horse, being ·65 horse for the barn-works and ·06 for the horse-works.

It was next tried in threshing barley. A quantity of sheaves were counted out and threshed. The time taken was 8 minutes 7 seconds; the counter of the testing machine registered 850 revolutions during that time, and the average power, as indicated by the diagram, equalled 18·14 lbs. During this experiment the machine worked well, and was fed in a very regular manner, but it was ascertained that a mistake had been made in the number of sheaves given to it, and it was decided to have the experiment repeated. Fifty sheaves of barley were then counted out, and the machine commenced threshing, but, by some oversight of the assistant, the tracing-pencil was not put to work,

and no indication of the power was given; consequently, this experiment was useless. Another 50 sheaves were taken, and,



while threshing the 24th sheaf, some cogs of the horse-wheel pinion were broken out, and the experiment ended. Upon examining the machine, it was found that the weight of the

upright shaft of the testing machine caused the horse-wheel cogs to work deeper into the pinion than they should have done; and Mr. Garrett earnestly requested leave to put on a new pinion, that the machine might be again tried, but as the Judges considered it a rule that whenever a breakage occurs the machine under trial is to be immediately withdrawn, and as they had acted on this rule in other cases, they could not do otherwise in this instance, without the sanction of the Stewards.

A meeting of the Stewards and Judges was convened, and it was decided that the rule of the Judges must be adhered to; but as it was clearly shown that 70 sheaves of barley, instead of 50 sheaves, were counted out in the first experiment, and that from that fact, and from the data obtained in the last experiment, a fair result could be obtained, it was decided that the Consulting Engineer (with the assistance of one of the mechanical Judges) should obtain that result.

The first experiment, reduced to 50 sheaves, took 5 minutes 52 seconds to thresh them, and the power of 3·15 horses to work the machine; the time multiplied by the power equals 18·52 horses to thresh 50 bundles of barley in one minute; the average power is indicated on the diagram given off by the testing machine, being 18·14 lbs.

The last experiment, similarly reduced, shows that 50 sheaves would have been threshed in 5 minutes 12 seconds; that it took 4·7 horse-power to work the machine, 24·44 horse-power to thresh 50 sheaves in one minute; and the diagram indicated 22·39 lbs. on the average during the time the machine was working.

From the foregoing facts it appears reasonable to suppose that over-feeding had no little share in breaking the machine, for the last experiment shows that the work would have been done in 40 seconds less time than it would have been done in the first experiment with barley, and it also shows that it took more power to do it. It may be alleged that this excess of power was owing to the cogs being too deep in gear; but if we compare the average power, 28·39 lbs. as indicated by the diagram while threshing wheat, with the last diagram, 22·39 lbs. while threshing barley, it will be seen that the strain upon the gearing was greater in the former than in the latter instance, and the difference *in the horses' power* arises from the machine working something faster in the last case. It must also be borne in mind that the friction of the machine was tried after the first experiment, and after the average diagram of power had been greater than it ever was afterwards during the last experiment, which indicates the irregular strain upon the machine. The following diagram shows the working of the machine, and the point at which it gave way.

Corn-dressing Machines.—In the trial of corn-dressing machines,

as will be seen by the following table, the contest was between Hornsby and Hensman.

First Trial.—With Corn as from the Threshing Machine, with sixty-two turns of Testing Machine.

Stand.	Art.	Name.	Weight on lever empty.	Weight on lever working.	Best Grain.			Tail Corn.			Screenings.		
			lbs.	lbs.	B.	P.	Q.	B.	P.	Q.	B.	P.	Q.
34	15	Holmes . .	15	$20\frac{1}{2}$	3	3	4	0	3	4	0	0	3
76	36	Garrett . .	$7\frac{1}{2}$	17	Tried and a slight accident.								
81	10	Hensman .	14	16	5	3	4	1	3	3			
20	5	Cornes . .	10	. .	3	0	$1\frac{1}{2}$	0	0	2			
40	1	Brinsmead.	15	17	3	4	0	1	2	0			
8	8	Hornsby. .	15	18	5	2	6	0	0	$0\frac{1}{2}$	0	0	5

Second Trial.—The Corn dressed a second time over. Six Bushels dressed by each.

Stand.	Art.	Name.	Turns.	Weight on Lever.	Height of Feeding Box.		Price.			Turns.	Power.
				lbs.	ft.	in.	£.	s.	d.		
34	15	Holmes . .	. .	. .	4	$5\frac{1}{2}$	12	0	0		
76	36	Garrett . .									
81	10	Hensman .	26	$15\frac{1}{2}$	4	9	13	10	0	$26 \times 15\frac{1}{2} = 403$	
20	5	Cornes . .	. .	. .	4	$5\frac{1}{2}$	12	10	0		
40	1	Brinsmead.	. .	. .	6	0	13	0	0		
8	8	Hornsby . .	. .	. .	4	9	13	10	0		
			25	17	. .			. .		$25 \times 17 = 425$	

The Judges have to observe that, in the first trial, Hensman had the advantage of Hornsby, both as to draught and the quantity of best grain; but Hensman's tail-corn was much too large in quantity. In the second trial the performance of the two machines was nearly equal, the draught being in favour of Hensman's, but in *time* and *division* of refuse corn Hornsby had the advantage. These two machines received a third trial, that the quality of the work might again be inspected. The result was, that Hensman's machine turned out best grain—a shade cleaner than Hornsby's: but as a drawback, the tail-corn had a large quantity of good corn intermixed with it.

From the result of the last trial, and the fact that the best parts of Hensman's machine had been copied from Hornsby's, and that the workmanship of the latter was superior to the former, we decided that Mr. Hornsby's machine was best entitled to the prize.

Wm. Lister.
Owen Wallis.

Report of the Judges on the Tile Machines.

The following five machines selected for trial were first tried at screening unground clay, but it was so full of gravel that the screens were immediately clogged with it. They were then tried with the ground clay, which contained a sufficient quantity of gravel to test their merits in the screening process. Clayton's screen has circular apertures; the others have parallel bars of round iron, and their sizes and the results of the trial are shown in the following table :—

Name.	Stand.	Article.	Size of Apertures.	Area of whole of Apertures.	Lbs. of Clay screened.	Men.	Boys.	Time.	Quality of Work.
			inches.	inches.				min.	
Whitehead . .	17	2	3/16	69	561	2	1	5	Very good.
Clayton . . .	9	1	5/16	42·24	715	2	2	..	Do.
Scraggs . . .	21	1	7/32	53·20	591	2	..	..	Do.
Williams . .	28	10	3/8	90·45	281	1	1	..	Indifferent.
Ainslie . . .	..	..	..	..	..	..	..	..	Not tried.

Ainslie's machine was selected for trial, but having no screening apparatus it was obliged to be rejected.

The other machines were then tried in making $1\frac{1}{2}$-inch pipes, with the following results—(time of trial ten minutes) :—

Name.	Stand.	Article.	Length of Pipes.	Diameter of Pipes.	Number of Pipes made.	Men.	Boys.	Time.	Quality of Pipes.
			inches.	inches.				min.	
Whitehead . .	17	2	$13\frac{1}{2}$	$1\frac{1}{2}$	724	2	2	10	Excellent.
Clayton . . .	9	1	$13\frac{1}{2}$	$1\frac{1}{2}$	539	2	2	..	Good.
Scraggs . . .	26	1	$13\frac{1}{2}$	$1\frac{5}{8}$	350	2	..	..	Do.
Williams . .	28	10	$12\frac{1}{2}$	$1\frac{1}{2}$	180	1	1	..	Do.
Clayton . . .	9	3	$13\frac{1}{2}$	$1\frac{1}{2}$	418	1	2	..	Very good.

The outside pipes from Williams's machine were mostly imperfect, which accounts for the small number produced. Clayton's, art. 3, is a copy from Whitehead's machine.

The next trial was with 9-inch pipes, but it could not be con-'dered a fair one, as Whitehead had not a horse on which to ›ive them less than 27 inches in length, and consequently

more difficult to set up than in Clayton's, which were only 13½ inches long. We give, however, the results below :—

Name.	Stand.	Article.	Length of Pipe made.	Diameter of Pipes.	Men.	Boys.	Time.	Quality of Pipes.
			inches.	inches.			min.	
Whitehead . .	17	2	106	9½	1	1	5	Fair.
Clayton . . .	9	1	234	8½	2	1	. .	Good.
Scraggs . . .	26	1	78	9	2	. .	. .	Do.

Whitehead's small machine and Clayton's vertical one were then tried in making 3-inch pipes, and the results were as follow :—

Name.	Stand.	Article.	Length of Pipes.	Diameter of Pipes.	Number of Pipes.	Men.	Boys.	Time.	Quality of Pipes.
			inches.	inches.				min.	
Whitehead . .	17	1	13½	3	170	1	1	10	Very good.
Clayton . . .	9	1	13½	3¼	195	2	1	. .	Do.

The following trials were then made on the Friction-Brake, or Dynamometer, with these results :—

Name.	Stand.	Article.	Length of Pipe in inches.	Diameter of Pipes.	Revolutions of Brake.	Friction of machine when full.	Friction when empty.	Price.	Quality of Pipes.
				inches.		lbs.	lbs.	£.	
Whitehead . .	17	2	888	1½	32	26	4	28	Very good.
Clayton . . .	9	1	686	1½	20	19	3½	29	Good.
Scraggs . . .	26	2	861	1⅝	37	23	4	15	Very good.
Whitehead . .	17	1	297	3	32½	22	4	21	Do.
Clayton . . .	9	1	270	3¼	.21	19	3½	29	Do.
Scraggs . . .	26	2	250	3⅜	36	18	4	15	Do.

From the above results a calculation was then made to ascertain the power required in making 1½-inch pipes by the above machines, and the following Table will show the comparative power required to produce 100 by each machine :—

Name.	Stand.	Article.	Number of Pipes.	Diameter of Pipes.	Length of Pipes.	Power required to produce them.	Price.	Quality of Pipes.
				inches.	inches.		£.	
Clayton . . .	9	1	100	$1\frac{1}{2}$	$13\frac{1}{2}$	874	29	Good.
Whitehead . .	17	2	100	$1\frac{1}{2}$	$13\frac{1}{2}$	1264	28	Very good.
Scraggs . . .	26	2	100	$1\frac{5}{8}$	$13\frac{1}{2}$	1333	15	Do.

As the Society, in the trial of all machines, considers it indispensable to submit them to the test of the dynamometer, in order to ascertain the amount of power required by each to produce certain results, and when tried by this test Clayton's machine, as shown above, was so much superior to the others which came into close competition with it, that the Judges felt they could not do otherwise than award the prize to it. They are of opinion, however, that in other respects Whitehead's machine is superior to Clayton's. His $1\frac{1}{2}$-inch pipes were decidedly superior in quality, and a much greater number were produced in a given time. It possesses also the advantage of being portable and more easily moved about the tilery, whereas Clayton's is almost necessarily a fixture. It can be worked either by two men and two boys, when a large quantity is required, or it can be worked by one of each, and is thus adapted to a smaller establishment. Clayton's, on the other hand, cannot be worked with less than two men and two boys, and more of the latter will generally be required. In the larger description of pipes Clayton's vertical machine has a decided advantage over all the horizontal ones. When Whitehead's machine was first exhibited at the York meeting it produced two rows of pipes from the same die-plate. It now produces only one, and the power required to work it is greatly increased.

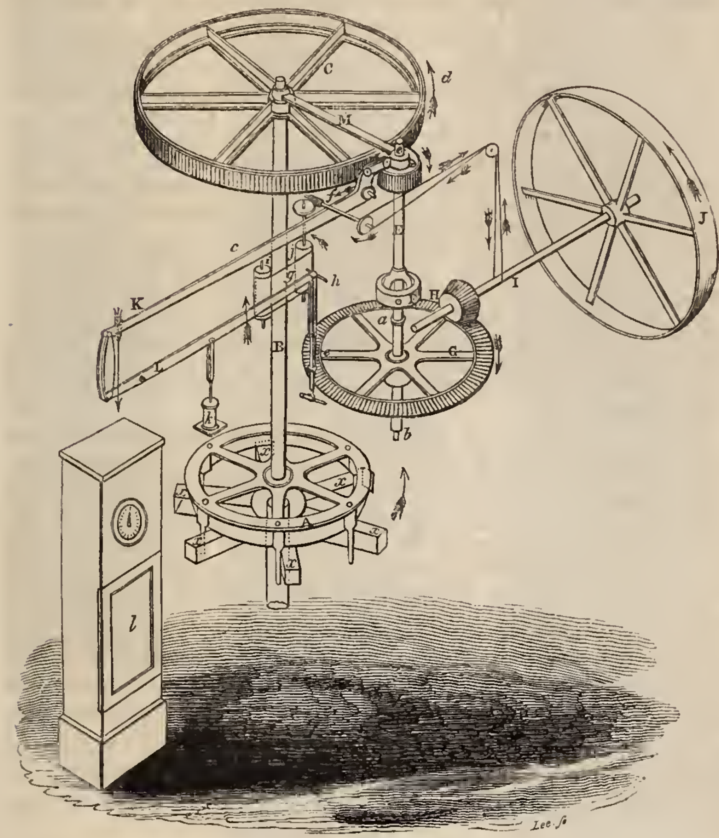
Owen Wallis.
William Lister.

Testing Apparatus.

The plate annexed represents the apparatus, constructed by Messrs. Easton and Amos, for *testing* the threshing machines under the immediate superintendence of its talented inventor, Mr. Amos, who, in his capacity of Consulting Engineer to the Society, has skilfully and successfully carried out the wishes of the Council in the important point of accurately testing the relative powers and comparative value of implements in general, but more especially in that most important one, the threshing-machine,

combining the trial of the horse-works with the barn part, the necessity of which was forcibly pointed out by Mr. Thompson in his report of last year.

Fig. 1.



Testing Apparatus for Threshing-Machines.

The following explanation of the diagrams is furnished by Mr. Amos :—

To enable the public generally, and the implement-makers in particular, to form an opinion of the testing-machine used at this meeting, I beg to submit the following sketch of its leading features, which I trust will be intelligible :—

See fig. 1. A is a flanch, provided with pins to take hold of short arms *x, x, x, x,* placed in the flanch of the horse-works where the horse-draughts are usually fixed. The flanch A is keyed upon the shaft B, and upon this shaft is keyed the wheel C. This wheel is 5 ft. $11\frac{5}{8}$ in. diameter, and has 120 cogs, on its periphery. Into this wheel the pinion D works,

carrying 20 cogs, and keyed upon the shaft E, which shaft has a *universal joint* F; so that, although the lower part of this shaft is secured in position by the bearings *a* and *b*, the upper part, *c*, would be free to move in any direction, were it not controlled by means hereafter described.

On the lower part of the shaft E is keyed the bevil-wheel G, carrying 100 cogs; into this wheel the pinion H works, carrying 21 cogs, and keyed upon the shaft I, which also carries a band-wheel J, carrying a strap in common with a band-wheel on a steam-engine that gives motion to the testing-machine, and through it to the threshing-machine under trial.

By a careful inspection of the figure it will be seen that when power is applied to the band-wheel J, and in the direction of the dotted arrow, the effect will be to turn the main wheel C in the direction of the arrow *d;* but if resistance to motion is caused by the short arms *x*, *x*, *x*, *x* of the horse-works to the flanch A, the shaft B and the wheel C will be immovable, and the pinion D and the upper end of the shaft E will move in the direction *c f*, unless they were retained in position by the combined action of the compound lever K and L (the radial bar M keeping the gear-work at its proper depth). Now, whatever stress may be placed upon the cogs of the wheel C, an equal stress is transmitted to the bearing C of the shaft E: hence the levers K and L become a *steelyard* for indicating the resistance of the work. At the end of the lever L is placed a Salter's balance *e*, for the purpose of keeping the power employed and the resistance to motion in equilibrium, and for measuring the intensity of these forces.

A pencil is placed in the end of the lever L at *h*, and traces a diagram upon the sheet of paper *g*, recording every variation of the power employed during the experiment; the sheet of paper passes from the roller *i* to the roller *j; k* is an oil cylinder, with a piston moving in it, and attached to the lever L, to check any momentary impulses either in the power of or the resistance to the machinery, and *l* is a clock to record the *time* occupied in each experiment. A *counter* is also attached to the shaft I, for the purpose of registering the number of revolutions the testing-machine makes during that time.

The shaft I makes 28·571, a little more than 28½, revolutions during the time that the shaft B, the wheel C, and the horse-wheel of the threshing-machine make one revolution. The power of the compound levers K and L is 75 to 1, and if the shaft I were only to make one revolution per minute, 601·42, or rather less than 601½ lbs. would be required on the end of the lever L to be equal to one horse-power. Hence the number of revolutions per minute made by the shaft I, multiplied by the weight on the lever L, and the product divided by 601·42, the quotient will equal the horses' power employed:

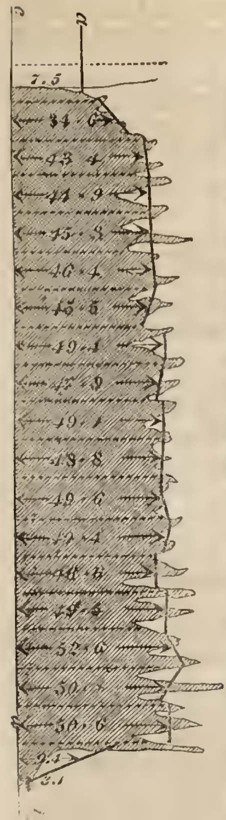
$$\text{Or } \frac{\frac{N}{T} \times W}{601{\cdot}42} = H\ P;$$

where N the number of revolutions made by the shaft I, W the weight on the lever L, T the *time* in minutes occupied in the experiment, and H P the horse-power employed.

When all is in readiness for commencing the trial of the implement, the machinery is put in motion and a few sheaves of wheat are passed through the threshing-machine, to enable the exhibitor to adjust his screen, concave, &c., in a proper manner. One hundred sheaves of wheat are then given to him, and, upon a signal being given by one of the Judges, the feeding commences. At that instant an attendant, by a simple contrivance, instantaneously puts in motion a counter (attached to the shaft

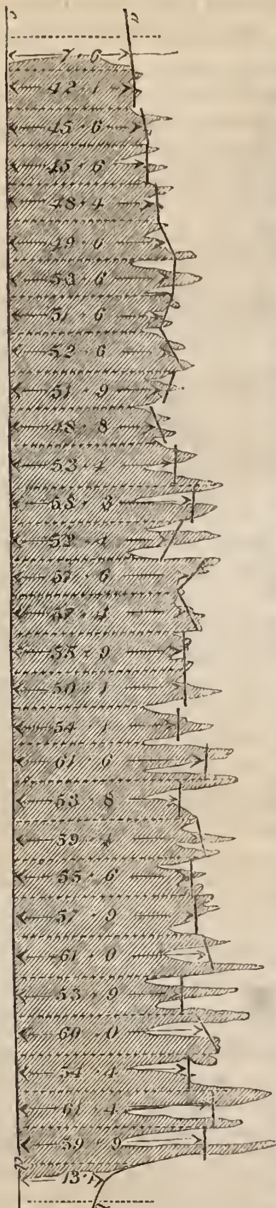
Diagrams of Threshing-machines.

Fig. 2.—Hensman.



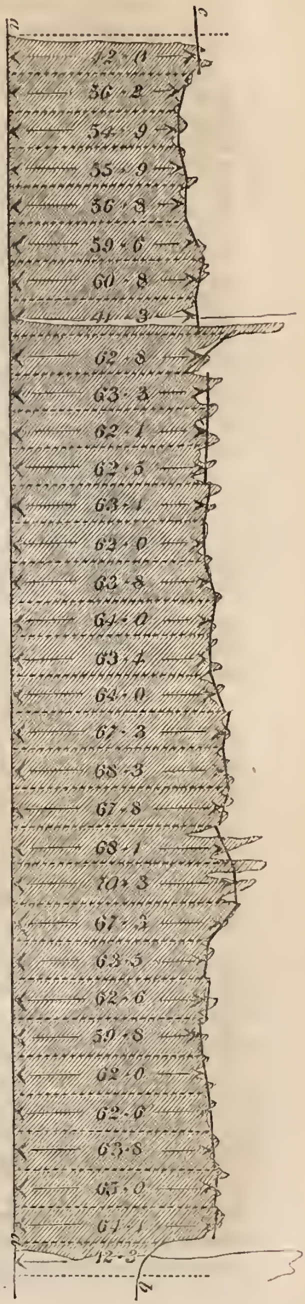
20)833·7(41·6 lbs.
the Average Power.

Fig. 3.—Mackelcan.



31)1594·6(51·4 lbs.
the Average Power.

Fig. 4.—Clayton & Co.



33)1983·3(30·1 lbs.
the Average Power

I), the rollers *i*, *j*, and the clock *l*; the lever L then rises, and the pencil *h* traces upon the sheet of paper *g* a diagram of the power required to work the machine.

Fig. 2 is a diagram to a reduced scale of the power required by the prize machine; the serrated or zigzag line on the right-hand side of the diagram is caused by irregular feeding; and to find the *average power*, a process has been followed, similar to that adopted by the land surveyor when measuring fields with crooked boundaries; a mean line *a*, *b* is carried through the irregularities, and the distances are measured from the base line *c*, *d*.

By a reference to the diagram it will be seen that the *average power* is $41\frac{6}{10}$ lbs., and this weight must be considered as applied to the lever L (fig. 1) at the end *h*.

The time taken to thresh 100 sheaves of wheat was 3 minutes 1 second = 3·016 minutes, and the counter indicated 206 revolutions of the shaft I (fig. 1) during that time.

In this experiment, W = 41·6 lbs.
T = 3·016 minutes,
and N = 206 revolutions.

And the rule, $$\frac{\left(\frac{N}{T}\right) \times W}{601{\cdot}42} = \text{H P.}$$

Hence $$\frac{\frac{206}{3{\cdot}016} \times 41{\cdot}6}{601{\cdot}42} = 473 \text{ horses' power required to work the machine.}$$

The time required to thresh 100 sheaves being 3·016 minutes, then $3{\cdot}016 \times 4{\cdot}73 = 14{\cdot}26$ horses' power required to thresh 100 sheaves of wheat in one minute.

Fig. 3 is a diagram of the 4-horse machine exhibited by Mackelcan; the average power is 51·4 lbs.; the counter indicated 415 revolutions; and the *time* taken was 3 minutes 14 seconds, being equal to 10·99 horses' power required to work the machine, and 35·49 horses' power to thresh 100 sheaves of wheat in one minute.

Fig. 4 is a diagram of the machine, with straw-shakers and winnowing machinery combined, exhibited by Clayton and Shuttleworth, to be worked by steam. The average power is 60·1 lbs.; the counter indicated 361 revolutions; and the time was 5 minutes 40 seconds, equal to 6·36 horse-power to work it, and 36·03 horses' power to thresh 100 sheaves of wheat in one minute.

This diagram shows a more regular line than the others; this may be accounted for by the fact that the machine took above $4\frac{1}{2}$ horses' power to drive it empty, being above two-thirds of the power it took to drive it when threshing: hence any little irregularity of feeding would increase the resistance from this cause in a much less ratio to the whole resistance than a similar irregularity would do in another machine where the power required to drive it empty is very small in proportion to the power required to drive it while working.

In designing a threshing-machine to work by horses and the minimum of power, so far as the gear-work is concerned, care should be taken to have good proportions in sizing the wheels: thus, if all the driving wheels were to be laid on each other (in the order that they work) in one heap, and the pinions to be similarly placed in another, each heap or pile should form a regular cone in diameters and strengths; the only deviation from this principle that can be safely adopted would be in the case of the *horse-wheel*, which may be as large as convenient.

General Remarks.

The implements exhibited at the meeting have greatly improved in character, both as to construction and workmanship, and the implement-makers have found that it is not to their advantage to exhibit implements of inferior description in their respective classes. Although the actual number of implements exhibited at Exeter may numerically be less than at some other meetings of the Society, the goodness and efficiency of those shown more than compensate for the slight decrease in number. By the report of the Judges on steam-engines it will be seen that the engine of Messrs. Hornsby and Son, which obtained the first prize, only consumed 7·56 lbs. of coal per horse-power per hour; also that the engine of Messrs. Clayton and Shuttleworth, which obtained the second prize, consumed 7·77 lbs. of coal per horse-power per hour; while the prize engine at Norwich consumed 11·5 lbs. per horse-power per hour—showing a saving in the expense of coal of upwards of 30 per cent. These *facts* are matters of great moment to the agriculturist wishing to purchase an engine, as it will induce him to be careful in selecting a proper implement, as no saving in the first cost of an engine can compensate him for the continual expense of the greater quantity of fuel consumed by one of inferior quality; and, in illustration of the above, the Consulting Engineer of the Society has furnished the compiler of this report with the following table, showing the advantage annually accruing to the purchaser of the best implement:—

A's Engine cost £162 10*s*.

	£.	*s*.	*d*.
Interest on £162 at 7½ per cent.	12	3	9
25 tons 7 cwt. 16 lbs. of coal, at 17*s*. 6*d*. per ton, consumed in 50 days	22	3	9
	£34	7	6

B's Engine cost £217.

	£.	*s*.	*d*.
Interest on £217 at 7½ per cent.	16	5	6
6 tons 8 cwt. 1 qr. 16 lbs. of coal, at 17*s*. 6*d*. per ton, consumed in 50 days	6	1	10
Balance	12	1	0
	£34	7	6

Thus showing a gain of 12*l*. 1*s*. 6*d*. per annum for the extra outlay of 54*l*. 10*s*. in the first cost of the engine, supposing the engine to be worked *fifty days* only in the year.

The experience gained at the Norwich meeting has not been lost sight of by the makers of threshing-machines. On the whole the machines exhibited at Exeter were generally much improved upon those of former meetings.

The prize machine at the Norwich meeting required a power equivalent to 2·78, or rather more than 2¾ horses' power to drive it empty, while the prize machine at Exeter took only 1·39 horses'

power to drive it under the same conditions, and did its work very well; and it will be seen, by referring to the tabular statement in the Judges' report, that it was entered as a four-horse machine, and that it took no more than 4·73, or rather less than $4\frac{3}{4}$ horses to work it under trial. The merit of this machine will be more clearly shown by contrasting it with one exhibited by Mackelcan, which was also entered as a four-horse machine, and took 2·34 horses' power to work it empty, nearly eleven horses' power to drive it under trial, and 13 seconds longer time to thresh 100 sheaves of wheat.

It is to be regretted that the exhibitors generally, when on trial, are anxious to do their work in the shortest possible time. Were they to feed and work their machines as they would in the farm-yard, the results obtained would be more in their favour, and the advantages possessed by the machine more clearly developed. This remark applies to all machines that are tested.

The chaff-cutting machines worked well, and the last improvement of Mr. Cornes is a very judicious one.

The dressing-machines generally are improved.

The tile-machines had undoubtedly the most searching trial they have ever been subjected to, and the results are given in the foregoing report of the Judges. The manufacturers of these machines should endeavour to form their *boxes* in such a manner that the size of the pistons should approach as nearly as possible to the total area of the openings of the dies when making the most useful sizes of pipes.

In testing the implements at these meetings, the three points most important to be attended to are the *quantity* and *quality* of the work that the machine will perform, and the *power* required to work it; and great care must be taken to keep a proper balance between these three principal requisites; for it may happen that, of two machines competing with each other, one of them may do its work a little better, and turn out more in quantity, while the second requires considerably less power to work it. In such a case, it by no means follows that the second machine is entitled to the prize, even though on calculation its economy of power more than made up for its smaller production: for if the power required by the first machine were not more than the man or the horse were reasonably expected to exert, no material advantage would be gained by reducing the power below that point; and it would be right to award the prize to that machine (notwithstanding its greater strength required to work it) that is found to turn out the greatest amount of work, of the best quality, in the day.

I cannot close this report without observing how much the Society, and especially all those who have to do with the executive business of the show, are indebted to the untiring zeal and

methodical arrangements of Mr. Brandreth Gibbs, the honorary director, so necessary to enable him to fulfil the multifarious and onerous duties which devolve upon him.

C. B. Challoner.

Portnall Park, November, 1850.

PRIZES OFFERED BY THE SOCIETY.

For the Plough best adapted for general purposes .	Seven Sovereigns.
For the Plough best adapted for Deep Ploughing .	Seven Sovereigns.
For the best One-way or Turn-wrest Plough .	Five Sovereigns.
For the best Paring Plough	Five Sovereigns.
For the best Subsoil Pulverizer	Five Sovereigns.
For the best Drill for general purposes, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered . .	Ten Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Pair-Horse Steerage Corn and Turnip Drill	Ten Sovereigns.
For the best Drill for small occupations . .	Five Sovereigns.
For the best Turnip Drill on the flat, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered . .	Ten Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Turnip Drill on the ridge, which shall possess the most approved method of distributing Compost or other Manures in a moist or dry state, quantity being especially considered . .	Ten Sovereigns.

N.B.—Other qualities being equal, the preference will be given to the Drill which may be best adapted to cover the manure with soil before the seed is deposited.

For the best Drop Drill, for depositing Seed and Manure	Ten Sovereigns.
For the Manure-Distributor which is best adapted for distributing broadcast any kind of compost or hand-tillage when in a moist state, and which is capable of adjustment for the delivery of any quantity from Two to Twenty bushels per acre .	Five Sovereigns.
For the best portable Steam-Engine, applicable to Threshing or other Agricultural purposes . .	Fifty Sovereigns.

For the second best portable Steam-Engine, applicable to Threshing or other Agricultural purposes	Twenty-five Sovereigns.
For the best portable Threshing Machine applicable to Horse or Steam-power	Twenty Sovereigns.
For the best Corn-Dressing Machine . . .	Ten Sovereigns.
For the best Grinding-Mill for breaking Agricultural produce into fine Meal	Ten Sovereigns.
For the best Linseed and Corn-Crusher . .	Five Sovereigns.
For the best Chaff-Cutter	Ten Sovereigns.
For the best Turnip-Cutter	Five Sovereigns.
For the best Oilcake Breaker for every Variety of Cake	Five Sovereigns.
For the best One-Horse Cart for general purposes	Ten Sovereigns.
For the best Light Waggon for general purposes	Ten Sovereigns.
For the best Machine for making Draining Tiles or Pipes for Agricultural purposes. Specimens of the Tiles or Pipes to be shown in the Yard: the price at which they have been sold to be taken into consideration, and proof of the working of the Machine to be given to the satisfaction of the Judges	Twenty Sovereigns.
For the best Set of Tools for General Draining .	Three Sovereigns.
For the best Heavy Harrow	Five Sovereigns.
For the best Light Harrow	Five Sovereigns.
For the best Cultivator, Grubber, and Scarifier .	Ten Sovereigns.
For the best Pair-Horse Scarifier . . .	Five Sovereigns.
For the best Horse Hoe on the flat . . .	Ten Sovereigns.
For the best Horse Hoe on the ridge . . .	Five Sovereigns.
For the best Horse Rake	Five Sovereigns.
For the best Horse Seed-Dibbler or Seed-Depositor not being a Drill	Ten Sovereigns.
For the best Cider Mill	Ten Sovereigns.
For the best Barrow Hand Drill, to work with cups	Three Sovereigns.
For the best Liquid Manure Distributor . .	Ten Sovereigns.
For the best Haymaking Machine . . .	Five Sovereigns.
For the best Gorse-Bruiser	Five Sovereigns.
For the best Cottage Stove or Range for burning Coals	Five Sovereigns.
For the best and most economical Steaming Apparatus for general purposes	Five Sovereigns.
Miscellaneous Awards and Essential Improvements	Silver Medals estimated at Twenty Sovereigns.
For the Invention of any New Implement . .	Such sum as the Council may think proper to award.

PRIZES OFFERED BY ROBERT AGLIONBY SLANEY, ESQ., M.P.

For the best Drain-Plough, to cut out, at one, two, or three cuts, to the greatest depth, with not more than four horses, so as to prepare a drain so far for deeper cutting	Ten Sovereigns.
For the best Plough, to fill in the soil cast out of drains, with not more than four horses (two and two abreast)	Ten Sovereigns.

JUDGES.

Charles John Carr	Belper, Derbyshire.
William Owen	Rotherham, Yorkshire.
William Lister	Dunsa Banks, Yorkshire.
John Overell	Aspeden, Herts.
Thomas Scott	Broom Close, Yorkshire.
J. H. Nalder	Alvescot, Gloucestershire.
Charles Paget	Ruddington Grange, Nottingham.
Thomas Hawkins	Assington Moor, Suffolk.
Owen Wallis	Overstone Grange, Northamptonshire.
T. P. Outhwaite	Bainesse, Catterick, Yorkshire.

Consulting Engineer—Charles Edwards Amos (of the Firm of Easton and Amos), The Grove, Southwark, Surrey.

AWARDS.

Description of Implement and Name of Exhibitor.	Prize.	Reference to Catalogue. Stand.	Article.	Price. £.	s.	d.
Ploughs.						
To William Ball, of Rothwell, near Kettering, for his Iron Plough for general purposes, marked "Criterion" Plough; invented by the exhibitor, and improved by James Biggs, of Desborough	£7	68	1	4	0	0
To John Howard and Son, of Bedford, for their Patent Iron Plough with Two Wheels, for deep ploughing, marked J A; invented and manufactured by the exhibitors . .	£7	10	4	4	4	0
To Henry Lowcock, of Raddon Court Farm, Thorverton, near Collumpton, for his Patent One Way or Turn Wrest Plough, with Ransome's Patent Trussed Iron Beam; invented and improved by the exhibitor, and manufactured by Ransomes and May of Ipswich	£5	87	1	6	0	0
To Thomas Glover, of Thrussington, near Leicester, for his Turf and Stubble Paring Plough; invented, improved, and manufactured by the exhibitor	£5	78	1	5	10	0
Subsoil Pulverizer.						
To John Howard and Son, of Bedford, for their Subsoil Pulverizer; invented and patented by the late John Read of London; improved and manufactured by the exhibitors . .	£5	10	8	5	10	0

AWARDS.

Description of Implement and Name of Exhibitor.	Prize.	Reference to Catalogue. Stand.	Article.	Price. £. s. d.
Drills.				
To Richard Garrett and Son, of Leiston Works, near Saxmundham, for their Drill for general purposes, and Depositing Compost; invented, improved, and manufactured by the exhibitors	£10	76	2	35 12 6
To Richard Hornsby and Son, of Spittlegate, near Grantham, for their Pair-Horse Ten Coulter Corn and Seed Drill; invented, improved, and manufactured by the exhibitors	£10	8	2	29 0 0
To Richard Garrett and Son, of Leiston Works, near Saxmundham, for their Seven Row Lever Drill, best adapted for small occupations: improved and manufactured by the exhibitors	£5	76	10	15 0 0
To Richard Hornsby and Son, of Spittlegate, Grantham, for their Six-row Turnip Drill on the flat, and for Depositing Compost; invented, improved, and manufactured by the exhibitors	£10	8	3	29 0 0
To Richard Hornsby and Son, of Spittlegate, Grantham, for their Two-row Turnip Drill on the ridge, and for Depositing Compost; invented and manufactured by the exhibitors	£10	8	4	21 0 0
To Richard Garrett and Son, of Leiston Works, near Saxmundham, for their Patent Drop Drill on the flat and ridge; invented and manufactured by the exhibitors . .	£10	76	5	24 10 0
Hand-Barrow Drill.				
To Richard Garrett and Son, of Leiston Works, near Saxmundham, for their Hand-Barrow Drill, to work with Cups; invented, improved, and manufactured by the exhibitors . .	£3	76	13	3 3 0
To John Holmes and Son, of Prospect Place, Globe Lane, Norwich, for their machine for Distributing Pulverized Manures broadcast; invented, improved, and manufactured by the exhibitors	£5	34	13	13 13 0
Liquid-Manure Distributor.				
To Thomas Robert, and John Reeves, of Bratton, near Westbury, Wilts, for their Liquid-Manure Distributor; invented by Thomas Chandler, of Stockton, Wilts; improved and manufactured by the exhibitors	£10	59	1	16 0 0

AWARDS.

Description of Implement and Name of Exhibitor.	Prize.	Reference to Catalogue.		
		Stand.	Article.	Price. £. s. d.
Harrows.				
To William Williams, of Bedford, and Lawrence Taylor, of Cotton End, near Bedford, for their set of Patent Four-beam Diagonal Iron Harrows for Heavy Land; invented by Samuel Taylor, of Cotton End; improved and manufactured by William Williams, of Bedford	£5	28	3	5 0 0
To John Howard and Son, of Bedford, for their set of Patent Jointed Iron Harrows for Light Land; invented by W. Armstrong and J. Howard of Bedford; improved and manufactured by the exbibitors . .	£5	10	20	4 17 6
Scarifiers.				
To Smitb and Co., of Stamford, for their improved Cultivator or Grubber; invented by S. Smith, of Northampton; improved and manufactured by the exhibitors . .	£10	62	5	14 0 0
To E. H. Bentall, of Heybridge, near Maldon, Essex, for bis Pair Horse Scarifier, invented and manufactured by the exhibitor . .	£5	71	1	6 10 0
Horse-Hoes.				
To Richard Garrett and Son, of Leiston Works, near Saxmundham, for their patent Horse-Hoe on the flat; invented and manufactured by the exhibitors	£10	76	14	15 0 0
To William Busby, of Newton-le-Willows, near Bedale, for his Horse-Hoe on the Ridge; invented, improved, and manufactured by the exhibitor	£5	18	6	2 10 0
Horse-Rake.				
To John Howard and Son, of Bedford, for their Patent Horse Drag Rake; invented and manufactured by tbe exhibitors . .	£5	10	26	7 7 0
Drain-tile or Pipe-Machines.				
To Henry Clayton. of the Atlas Works, 21, Upper Park Place, Dorset Square, London, for his Patent Double-Action Tile-Pipe and Brick Machine, invented, improved, and manufactured by tbe exhibitor . . .	£20	9	1	25 0 0
To Mapplebeck and Lowe, of Birmingham, for their set of Draining Tools; manufactured by the exhibitors	£3	89	42	1 14 0

AWARDS.

Description of Implement and Name of Exhibitor.	Prize.	Reference to Catalogue.		
		Stand.	Article.	Price.
				£. s. d.
Steam-Engines.				
To Richard Hornsby and Son, of Spittlegate, Grantham, for their Nine-horse power improved Portable Steam-Engine; invented, improved, and manufactured by the exhibitors	£50	8	9	275 0 0
To Clayton, Shuttleworth, and Co., of Lincoln, for their Seven-horse power Portable Steam-Engine with improved Tubular Boiler; invented, improved, and manufactured by the exhibitors	£25	5	3	217 0 0
Steaming Apparatus.				
To William Prockter Stanley, of Peterborough, for his Portable Steam-Generator with Compound Tub and Vegetable Pan; invented, improved, and manufactured by the exhibitor	£5	64	2	14 15 0
Threshing Machines.				
To William Hensman and Son, of Castle Works, Woburn, Beds, for their Bolting Threshing Machine for Steam or Horse Power; invented, improved, and manufactured by the exhibitors	£20	81	7	53 0 0
Corn-dressing Machines.				
To Richard Hornsby and Son, of Spittlegate, Grantham, for their registered Corn-dressing Machine; invented, improved, and manufactured by the exhibitors	£10	8	8	13 10 0
To Clayton, Shuttleworth, and Co., of Lincoln, for their Grinding Mill for breaking agricultural produce into fine meal; invented, improved, and manufactured by the exhibitors	£10	5	5	45 0 0
To William Procktor Stanley, of Peterborough, for his Linseed and Corn Crushing-machine; improved and manufactured by the exhibitor	£5	64	5	12 0 0
Chaff-cutting Machine.				
To John Cornes, of Barbridge, near Nantwich, for his registered Chaff-cutting Machine with three Knives; invented, improved, and manufactured by the exhibitor . . .	£10	72	1	14 0 0

AWARDS.

Description of Implement and Name of Exhibitor.	Prize.	Reference to Catalogue.		
		Stand.	Article.	Price.
				£. s. d.
CARTS.				
To William Busby, of Newton-le-Willows, near Bedale, for his One-horse Cart, or Harvest-cart; invented by William Lister, Esq., of Dunsa Banks, Yorkshire, and manufactured by the exhibitor	£10	18	17	11 10 0
WAGGONS.				
To William Crosskill, of the Iron Works near Beverley, for his Light Waggon; improved and manufactured by the exhibitor . .	£10	4	26	29 0 0
HAYMAKER.				
To Smith and Co., of Stamford, for their Patent Double-action Haymaker; invented, improved, and manufactured by the exhibitors	£5	62	1	15 15 0
TURNIP-CUTTING MACHINE.				
To Bernhard Samuelson (successor to the late James Gardner), of Banbury, for his Patent Double Action Turnip-cutting Machine; invented by the late James Gardner, improved by the executors of the late James Gardner, and manufactured by the exhibitor . .	£5	25	2	5 10 0
OIL-CAKE MACHINE.				
To William Newzam Nicholson, of Newark-on-Trent, for his Machine for Breaking Oil-cake for Beasts and Sheep, and Rape-cakes for Tillage; invented and manufactured by the exhibitor	£5	92	3	5 5 0
COTTAGE RANGE.				
To William Newzam Nicholson, of Newark, for his Cottage Range, with registered and patented improvements; invented, improved, and manufactured by the exhibitors . .	£5	92	7	1 15 0 to 2 10 0
MISCELLANEOUS.				
To Richard Hornsby and Son, of Spittlegate, Grantham, for their improvement to the Steerage of Drills, and the adoption of Vulcanised India Rubber Pipes in place of Tin Conductors for Seed	Silver Medal.	8	2	26 10 0

AWARDS.

Description of Implement and Name of Exhibitor.	Prize.	Reference to Catalogue. Stand.	Article.	Price.
				£. s. d.
To John Fowler, jun., of Melksham, Wilts, for his Wooden Pipe-making Machine; invented by the exhibitor, and manufactured by William Eyres, of Melksham—his Draining Plough; invented by the exhibitor, and manufactured by Stratton and Co., of Bristol; and his Windlass for drawing the Draining Plough—invented by the exhibitor, and manufactured by William Eyres, of Melksham	Silver Medal.	75	1 3 1	70 0 0 8 10 0 5 10 0
To Edward Hill and Co., of Brierley Hill Iron-Works, near Dudley, for the Expansion Movement in their Horse Hoe; invented and manufactured by the exhibitors . .	Silver Medal.	81	5	2 10 0
To Richard Read, of 35, Regent Circus, Piccadilly, London, for his Double Cistern Patent Agricultural Fire Engine; invented, improved, and manufactured by the exhibitor.	Silver Medal.	58	3	18 18 0
To William Newzam Nicholson, of Newark, for his Cottage Stove, with Registered and Patent improvements; invented. improved, and manufactured by the exhibitor . . .	Silver Medal.	92	15	3 0 0
To Bernhard Samuelson (successor to the late James Gardner), of Banbury, for his Churn; invented by Charles Anthony, of Pittsburgh, United States, and manufactured by the exhibitor	Silver Medal.	25	17	4 10 0
To William Crosskill, of the Beverley Iron-Works, near Beverley, for his Permanent and Portable Farm Railway, with Points, Curves, Connecting Railway, and Train of Railway Trucks; invented, improved, and manufactured by the exhibitor . . .	Silver Medal.	4	61 62 63	121 4 0

COMMENDATIONS.

Richard Hornsby and Son, of Spittlegate, Grantham, for their Drill for General Purposes; invented, improved, and manufactured by the exhibitors	Highly commended.	8	1	52 0 0
Thomas Robert, and John Reeves, of Bratton, near Westbury, Wilts, for their Patent Liquid Manure Drop Drill; invented by Thomas Chandler, of Stockton, Wilts, improved and manufactured by the exhibitors	Highly commended.	59	2	25 0 0

COMMENDATIONS.

Description of Implement and Name of Exhibitor.	Prize.	Reference to Catalogue.		
		Stand.	Article.	Price. £. s. d.
William Busby, of Newton-le-Willows, near Bedale, for his Two-Wheeled Plough for General Purposes	Highly commended.	18	3	4 8 0
William Crosskill, of the Beverley Iron-Works, near Beverley, for his Uley Cultivator; invented by John Morton, of Whitfield, improved by Richard Clyburn of Uley, and manufactured by the exhibitor . .	Highly commended.	4	50	12 12 0
William Crosskill, of Beverley, for his Patent Serrated Roller and Clod Crusher; invented, improved, and manufactured by the exhibitor	Highly commended.	4	4	19 10 0
Richard Garrett and Son, of Leiston Works, near Saxmundham, for their Portable Steam Engine; improved and manufactured by the exhibitors	Highly commended.	76	22	205 0 0
William Busby, of Newton-le-Willows, near Bedale, for his Dibbling Drill adapted for small farmers; invented by Rev. W. Wharton, of Barningham, and manufactured by the exhibitor	Commended.	18	18	15 15 0
William Smith, of Kettering, for his Steerage Horse Hoe, adapted for small occupations; invented, improved, and manufactured by the exhibitor	Commended.	61	2	4 10 0
Dufaur and Co., of 21, Red Lion Square, London, for their Patent Hand Manure Distributor; invented by Dr. Newington of Hastings, and manufactured by the exhibitors . .	Commended.	73	7	5 0 0
William Hensman and Son, of Castle Works, Woburn, Beds, for their Patent Iron Plough for deep ploughing; invented, improved, and manufactured by the exhibitors . .	Commended.	81	4	4 5 0
. Gray and Sons, of Uddington, near Glasgow, for their Subsoil Pulverizer; invented, improved, and manufactured by the exhibitors	Commended.	80	4	6 10 0
Richard Garrett and Son, of Leiston Works, near Saxmundham, for their Patent Horse Hoe on the Ridge; invented and manufactured by the exhibitors	Commended.	76	16	12 0 0
William Crosskill, of the Iron Works, near Beverley, for his Norwegian Harrow; improved and manufactured by the exhibitor .	Commended.	4	51	13 10 0
John Milward, of Newton Abbot, for his Potato Plough; improved and manufactured by the exhibitor	Commended.	35	3	6 10 0

COMMENDATIONS.

Description of Implement and Name of Exhibitor.	Prize.	Reference to Catalogue.				
		Stand.	Article.	Price.		
				£.	s.	d.
Thomas Moore, of Newton St. Cyres, near Exeter, for his Gutter Plough; invented by John Bickford, of Crediton; improved and manufactured by the exhibitor . . .	Commended.	91	4	5	5	0
Edward Hill and Co., of Brierley Hill Iron Works, near Dudley, for their Wrought Iron Skim Plough; invented and manufactured by the exhibitors	Commended.	84	2	6	0	0
John Whitehead, of Preston, for his Drain Pipe and Tile Machine; invented, improved, and manufactured by the exhibitor . . .	Commended.	17	2	28	0	0
William Hensman and Son, of Castle Works, Woburn, Beds, for their Double Blast Winnowing Machine; invented, improved, and manufactured by A. Pridmore and Sons, of Thorpe Satchville, Leicestershire . .	Commended.	81	10	13	10	0
Smith and Co., of Stamford, for their Chaff-Cutter; invented, improved, and manufactured by the exhibitors	Commended.	62	6	17	0	0
Deane, Dray, and Deane, of Swan Lane, Thames Street, London, for their Portable Steam Engine of four-horse power; invented, improved, and manufactured by George Howe, of Southwark	Commended.	12	1	200	0	0
Barrett, Exall, and Andrewes, of Katesgrove Iron Works, near Reading, for their Seven-Horse Power Portable Steam Engine; invented and manufactured by the exhibitors . .	Commended.	39	43	196	0	0
Barrett, Exall, and Andrewes, of Katesgrove Iron Works, for their Two-Horse Power Patent Safety Horse Gear, adapted for Threshing Machines; invented and manufactured by the exhibitors	Commended.	39	37	12	12	0
Barrett, Exall, and Andrewes, of Katesgrove Iron Works, for the Concentric Motion for regulating the Concaves of Threshing Machines adapted to their Gear Work; invented and manufactured by the exhibitors . .	Commended.	39	34	39	0	0

XXV.—*On the Kohl-Rabi.* By J. Towers.

To Mr. Pusey.

Dear Sir,—Having had occasion, some years since, to investigate the culture of the kohl-rabi, I beg to send you such particulars as have come to my knowledge. I had been assured by a gentleman who had long resided in India that the white variety (to which, he said, they in the East had applied the name of *knol-khol*) formed one of the best vegetable dainties of the table, being, when well boiled, tender in pulp, almost like a custard, and of the most delicate flavour. It is somewhat difficult to procure genuine seed in England, and my Croydon friends, who plant it in the large way for cattle-food, raise the seed from the latest transplantations, or import it from Germany. I sowed it in a garden-plot, in the manner of cabbage seed; and when the plants had attained a fair size, in May, or early June, transferred them to a prepared plot in an orchard, apart from trees, setting each in rows, in every way about the distance required for middle-sized broccoli plants. I thus obtained both varieties,—the purple and the greenish white. Both grew at first like broccoli, but gradually the stems began to enlarge, and became swoln. They attained their full size; but being of slow growth in our cold climate, they never became tender when boiled, which a plant forced forward by the vaporous heat of the East Indies would do. The red sort was the coarser; but indeed one or the other, when boiled for the cow or pigs, yielded so unpleasant a smell, that it was soon abandoned, and especially as, whether raw or boiled, the root communicated a most disagreeable rank flavour to milk. I thus acquired the method of growing kohl-rabi, and noticed the very great strength and fibrosity of the lower stem, which raised the bulb four to six inches above the ground; but when I came to Croydon, and saw the great breadths cultivated by the best farmers, I could not discover that tall and thick development of stem. Upon inquiry of Mr. Davis, I was informed that a more delicate variety had been imported, the bulb of which was better and larger, but the portion of stem below its bulbous expansion more slender. In 1847 I witnessed the entire success of large crops in this neighbourhood, during that year of great heat and protracted drought, and have therefore made it a point to ascertain the practice of the several cultivators. It was observed upon four farms of very different qualities of soil, but fine and highly productive upon all. As I believe that Mr. Hewitt Davis supervised three of those farms at that time, I cannot do better than extract a few lines from his 'Farming Essays,' published in 1848, and pre-

sented to me by the author, whose farm at Spring Park I occasionally inspected :—

"My practice," he said, "is to prepare a seed-bed, by well digging and dressing in the winter a corner of my earliest piece of tares. The seed is sown in the end of February, or early in March, thinly in rows twelve inches asunder, and kept perfectly clean by hoeing and hand-weeding; and as the tares are cleared off in May and June, the ground is deeply ploughed, ridged up, dressed, and planted. The plants at first are placed three feet apart, the ridges being 28 inches asunder; but as the season advances the distance between the plants is diminished. The value of the root in any season is very considerable, but more particularly after a dry summer, when most other winter food is scarce. I am this year very fortunate, having on each of my farms a considerable breadth."

"Upon a field of ten acres broken up from heath last year (1846) (part of Bagshot-heath), I have at this moment more winter food to the acre than is commonly grown on good soils in favourable seasons from any other root; and this, too, has been raised without the aid of any purchased manure, and on land hitherto supposed of no value, and incapable of any paying produce for cultivation."—(Page 70.)

Here I beg to offer a few remarks.

On another farm of about 60 acres the plant is not grown on ridges, but upon the flat, after any crop which may be off the ground. The seed is sown in long rows at the side of a field, four or five of these together, at about the distance asunder mentioned by Mr. Davis. Between the middle of May and of June, the land (a fine mellow, sandy loam) devoted to the bulbing crop, is manured with farm-yard dung, half reduced, deeply ploughed, and harrowed to a smooth surface. If rain have fallen sufficient to render the ground somewhat moist, but not adhesive, the plants are taken from the seed-bed and set, one by one, in straight rows, about 27 inches apart, the plants standing a yard asunder in the ranks. Should rain fall in moderate quantity soon after the setting, the plants may be considered secure, and will bulb without failure; but if no rain come for some days, a little flagging will follow, and perhaps the loss of a plant here and there, which can easily be supplied. The *grand operation*, and one which above all bears upon the perfect development of the plant, consists in regular horse-hoeings, duly performed, so as effectually to destroy every weed, and to open the surface of the ground, so long as the spreading of the leaves will admit the safe passage of the hoe. It is to this circumstance, which demands so much vigilance and timely labour, that I am apt to ascribe the absence of this excellent and superior fodder plant, which is, *de facto*, proved beyond doubt to be the *bulb of dry seasons*. The weather at the *time of transplanting* forms the chief obstacle to success, some moisture and a few showers being indispensably required to start the plants, by the production of new rootlets. I have seen in the present year, on the 60 acre farm, one *first*

main plantation for earliest *bulbs;* a second of large extent after early *Shaw* potatoes; a third, after the first corn crop; and as there are thousands of seedlings yet in the seed-beds, I think it likely that another plot of several acres will be occupied by plants intended for spring food, if not for the production of seed. I close this communication by an extract from a note received on the 3rd September, from a first-rate grower, on the subject of the acreable yield :—

"As the weight of bulbs from an acre was never taken, it cannot be exactly given; but having grown bulbs weighing 16 lbs. and 17 lbs. each, although they are set out *thinner* than swedes, they are more *certain.* They retain their leaves all winter; and I consider I can grow as much weight per acre, weighed in January, as of swedes; and certainly I give the preference to kohl-rabi, as to comparative nourishment. Unfortunately it has seldom justice done to it: the seed is sown too late, and the planting made so likewise. It is a most valuable root."

As to mildew or disease, I never saw or heard of either; and I can distinctly add that I observed the plants to thrive better in the dry summers of 1847 and 1849 than during the intermediate wet one of 1848.

Yours faithfully,

Croydon, 2nd September, 1850. J. TOWERS.

XXVI.—*Fourth Report on the Analysis of the Ashes of Plants.* By J. THOMAS WAY and G. H. OGSTON.

THE analyses which are given in the following pages have been accumulating during the eighteen months which have elapsed since the appearance of the last Report.* Amongst them will be found some which at first sight would seem to be repetitions of those which have been before published. Thus, for instance, in the first paper, which was mainly devoted to the mineral history of wheat, the analyses of a few isolated specimens of barley and oats were given. As, however, both of these crops appeared to merit a closer examination than they at that time received, we have since analyzed other specimens in order to obtain the data for drawing a fair comparison between the different cereal crops.

The analyses are about ninety in number, and embrace the examination of the following crops, which we enumerate for the convenience of reference.

Oats and Oat Straw; Barley and Barley-straw; Maize, Grain, and Straw; Kohl Rabi, bulb and leaves; Cow Cabbage and stalk; Red

* Their publication has been delayed by no fault of Mr. Way's, but for want of space in the Journal.—Ph. P.

Carrots and leaves; Hops, flowers, leaves, and bine; Potatoes, tubers and haulm; Flax, the various parts; Various Seeds, Gorse, Green Rape, and the most important Natural and Artificial Grasses.

The specimens of oats which we are about to describe were grown for us in the year 1847, on a stiff clay and a silicious sand, by the kindness of Mr. Druce, of Ensham, near Oxford, and Mr. Morton, of Whitfield, respectively. They formed part of a series including barley, oats, peas, and beans, of which the two latter have already been described. The varieties of oats selected were the Hopeton and the Poland, the seed being obtained from Messrs. Gibbs, of Half-Moon Street.

Hopeton Oats.

Per centage of water and ash in three specimens of Hopeton oats:—

	Water.	Ash.	Ash calculated on dry substance.
No. 1.—The Seed	10·20	2·36	2·62
No. 2.—Produce on Clay	10·20	3·57	3·75
No. 3.—Produce on Sand	11·25	3·23	3·63

The composition of the ash was as follows:—

Composition in 100 parts of the ash of Hopeton oats:—*

	No. 1. The Seed.	No. 2. Produce on Clay.	No. 3. Produce on Sand.
Silica	51·51	47·80	41·74
Phosphoric Acid	18·30	23·60	26·18
Sulphuric Acid	2·54	2·26	1·95
Carbonic Acid	1·35	none.	none.
Lime	2·76	4·19	4·06
Magnesia	6·79	6·09	6·28
Peroxide of Iron	trace.	·41	2·05
Potash	13·58	14·82	15·95
Soda	·46	·80	1·73
Chloride of Potassium	none.	..	..
Chloride of Sodium	2·64	..	..
Total	99·93	99·97	99·94

The *total* sulphur in 1000 grains of the *undried* specimens was found to be—

Seed.	Produce on Clay.	Produce on Sand.
3·51	2·00	1·76

Reserving any remarks which may arise out of these analyses until we have the whole subject before us, we pass on to the specimens of potato-oats.

* It is to be understood that the oats were analyzed with their envelopes just as they are separated from the straw in the threshing.

Per centage of water and ash in potato oats:—

	Water.		Ash.		Ash calculated on dry substance.
No. 1.—Seed	9·06	..	2·48	..	2·72
No. 2.—Produce on Clay .	10·20	..	3·14	..	3·50
No. 3.—Produce on Sand .	10·20	..	3·26	..	3·63

The composition of these ashes is given in the following table:—

Composition in 100 parts of the ash of potato-oats:—

	No. 1. Seed.	No. 2. Produce on Clay.	No. 3. Produce on Sand.
Silica	39·75	42·64	46·55
Phosphoric Acid . .	29·16	28·20	25·43
Sulphuric Acid . .	1·44	·40	1·90
Carbonic Acid . . .	..	..	..
Lime	3·25	3·56	3·76
Magnesia	7·34	6·47	4·93
Oxide of Iron . . .	·74	·53	1·32
Potash	15·88	17·42	13·10
Soda	2·12	·78	3·00
Chloride of Potassium .	..	..	..
Chloride of Sodium .	..	..	..
Total . . .	99·98	100·00	99·99

The *total* sulphur of 1000 grains of potato-oats undried:—

Seed.		Produce on Clay.		Produce on Sand.
2·02	..	1·60	..	1·72

The differences in composition between these various specimens are considerable, but we in vain seek to trace them in any consistent way to the influence of the soil. There can be no doubt whatever that a direct influence is exerted by the nature of the soil, the manure, and the season, upon the mineral characters of the different crops; but a knowledge of these variations is only to be arrived at by joint experiments in the field and laboratory, conducted with great care and in the most varied manner. We have before observed that the analysis of these different series was undertaken more with the view of obtaining sufficient data for the average composition of the respective crops, than in the expectation of gaining much insight into the cause of the variations to which they are subject; although if any light could have been thrown upon this part of the question, it would have been an additional advantage.

A comparison of the ash of oats with that of wheat would at first sight appear favourable to the non-exhausting character of the former. Thus wheat, it will be remembered, averages 45

per cent. of its ash in phosphoric acid and 31 per cent. of potash, the quantities of these two substances in oats being something more than half these numbers: much of this difference, however, is due to the high per centage of silica in oats—a substance which has comparatively no place in the composition of the grain of wheat. The further discussion of this point will be deferred till we have exhibited the analysis of oat-straw, to which we now pass.

Per centage of water and ash in the straw of oats:—

	Water.	Ash.	Ash calculated on dry substance.
Straw of Hopeton Oats on Clay . .	11·85	5·96	6·76
,, ,, on Sand . .	9·44	4·41	4·95
Straw of Potato-Oats on Clay . . .	11·40	4·68	5·20
,, ,, on Sand . . .	10·20	4·82	5·36

The composition of these ashes is given in the following table:—

Composition in 100 parts of the ash of oat straw with the chaff, on clay and on sand:—*

	Straw of Potato-Oats.		Straw of Hopeton Oats.
	On Clay.	On Sand.	On Sand.
Silica	49·54	45·69	53·41
Phosphoric Acid . .	5·32	7·02	2·86
Sulphuric Acid . .	2·25	3·41	4·36
Carbonic Acid . . .	—	4·08	—
Lime	8·61	7·52	4·89
Magnesia	5·47	3·58	2·33
Peroxide of Iron . .	1·12	·64	2·70
Potash	21·72	20·61	16·06
Soda	2·57	3·23	—
Chloride of Potassium .	—	—	8·12
Chloride of Sodium .	3·38	4·14	5·24
Total . . .	99·98	99·95	99·97

The total sulphur on 1000 grains of these straws being (on the undried straw)—

Hopeton-Oat Straw. On Clay.	Hopeton-Oat Straw. On Sand.	Potato-Oat Straw. On Clay.	Potato-Oat Straw. On Sand.
1·31	1·21	1·37	2·12

From the foregoing results we may with tolerable safety deduce the average mineral composition of oats and oat-straw.

* The ash of the Hopeton-oat straw from clay soil was analyzed, but the book in which the results were entered was lost, and we were prevented by want of material from making them good.

Mean mineral composition of oats and oat-straw :—

	Mean of 3 Specimens of Hopeton Oats.	Mean of 3 Specimens of Potato-Oats.	Mean of 6 Specimens of Oats (Hopeton and Potato).	Mean of 3 Specimens of Oat Straw.
Percentage of Ash .	3·05	2·96	3·00	4·64
Silica	47·08	42·98	45·03	49·56
Phosphoric Acid . .	22·69	27·60	25·14	5·07
Sulphuric Acid . .	2·25	1·25	1·75	3·35
Carbonic Acid . .	·45	—	·23	1·36
Lime	3·67	3·52	3·59	7·01
Magnesia	6·39	6·25	6·32	3·79
Peroxide of Iron . .	·82	·86	·84	1·49
Potash	14·78	15·47	15·13	19·46
Soda	·99	2·07	1·53	1·93
Chloride of Potassium	—	—	—	2·71
Chloride of Sodium .	·88	—	·44	4·27
Total . .	100·00	100·00	100·00	100·00

In the two first columns of the table the averages of Hopeton and potato-oats are contrasted. The third and fourth columns give the average composition of all the specimens examined.

We have before observed that the difference in composition between the ash of oats and wheat is (with the exception of silica) rather apparent than real. A very simple calculation, founded on the preceding table, will serve to prove this proposition in the case of the most important constituents—the potash and phosphoric acid. The grain of wheat, on an average of a great number of specimens, contains 1·67 of ash, of which 45·00 per cent. is phosphoric acid and 31·37 is potash.

The grain of oats gives an average of 3·00 per cent. of ash, of which 25·14 per cent. is phosphoric acid and 15·13 potash; or only about half the per centage quantities of each that occur in the ash of wheat. Mark now the similarity when a *given weight* of each grain is compared :—

	Phosphoric Acid.	Potash.
1000 lbs. of wheat, at 1·67 of ash, 45 per cent. of which is phosphoric acid and 31·37 potash, will contain	7·52 ..	5·24
1000 lbs. of oats, at 3·00 per cent. of ash, of which 25·14 per cent. is phosphoric acid and 15·13 per cent. potash, will contain	7·54 ..	4·54

So that equal weights of wheat and oats will require an amount of phosphoric acid and potash which for practical purposes may be looked upon as identical.

The following quantities of the different mineral matters are taken up by a fair crop of oats, the straw being supposed to be about half as much again in weight as the grain. 48 bushels of oats, at 42 lbs. to the bushel, will weigh 2016 lbs., containing 60·5 lbs. of ash. 3024 lbs. of straw and chaff will contain 138·4 lbs. of ash :—

Mineral matter removed from an acre of land by a crop of oats:—

	In the Grain.	In the Straw and Chaff.	In the whole Crop.
	lbs.	lbs.	lbs.
Silica	27·2	69·6	96·8
Phosphoric Acid	15·2	7·1	22·3
Sulphuric Acid	1·1	4·7	5·8
Lime	2·2	9·8	12·0
Magnesia	3·8	5·3	9·1
Peroxide of Iron	·6	2·1	2·7
Potash	9·2	27·3	36·5
Soda	·9	2 7	3·6
Chloride of Potossium	..	3·8	3·8
Chloride of Sodium	·3	6·0	6·3
Total	60·5	138·4	198·9

The reader who will refer to the first report on ashes (Journal of the Society, vol. vii., part ii.) will find that the *exhausting* character of oats (if indeed exhaustion is connected with mineral composition at all) is but little different from that of wheat.

Barley.

The specimens of barley were grown at the same time and under the same circumstances as those of oats just described. The varieties were the Chevalier and the Moldavian, the seed being obtained, as in the other case, from Messrs. Gibbs.

Chevalier Barley.

Per centage of water and ash in three specimens of Chevalier Barley:—

	Water.	Ash.	Ash calculated on dry substance.
No. 1. The seed	12·50	2·03	2·32
No. 2. Produce on clay	13·20	2·30	2·65
No. 3. Produce on sand	13·20	2·15	2·47

Composition in 100 parts of the ash of Chevalier Barley:—

	No. 1. The Seed.	No. 2. Produce on Clay.	No. 3. Produce on Sand.
Silica	29·79	22·25	22·08
Phosphoric Acid	25·32	37·67	38·26
Sulphuric Acid	1·30	2·82	·92
Carbonic Acid	4·35	none.	none.
Lime	3·62	1·96	2·97
Magnesia	4·78	10·00	8·00
Peroxide of Iron	1·54	·87	·84
Potash	26·83	22·43	24·97
Soda	none.	1·42	·51
Chloride of Potassium	none.	none.	none.
Chloride of Sodium	2·47	·56	1·44
Total	100·00	99·98	99·99

The *total* sulphur on 1000 grains of these specimens undried was—

	Grains.
No. 1. The seed	3·53
No. 2. Produce on clay	·96
No. 3. Produce on sand	1·21

Before making any observation upon the foregoing analyses we shall give the results in the case of Moldavian barley.

Per centage of water and ash in Moldavian Barley:—

	Water.		Ash.		Ash calculated on dry substance.
No. 1. The seed	11·20	..	2 03	..	2·28
No. 2. Produce on clay . . .	11·24	..	2·31	..	2·55
No. 3. Produce on sand . . .	13·00	..	1·79	..	2·07

The quantity of ash yielded by the seed of Moldavian and Chevalier barley and of their produce on clay is singularly alike, the numbers being almost identical; but the similarity vanishes when the produce on sand is examined.

Composition in 100 parts of the ash of Moldavian Barley:—

	No. 1. Seed.	No. 2. Produce on Clay.	No. 3. Produce on Sand.
Silica	27·66	30·35	28·09
Phosphoric Acid . .	37·99	30·08	32·92
Sulphuric Acid . .	·39	·47	·53
Carbonic Acid . . .	none.	none.	none.
Lime	4·20	1·26	1·88
Magnesia	8·15	9·32	8·47
Peroxide of Iron . .	·93	·24	·10
Potash	19·78	26·61	22·46
Soda	·89	1·26	4·93
Chloride of Potassium .	..	..	..
Chloride of Sodium .	traces.	·41	·61
Total	99·99	100·00	99·99

The total sulphur on 1000 grains of Moldavian barley undried was found to be—

	Grains.
No. 1. The seed	1·51
No. 2. Produce on clay	2·42
No 3. Produce on sand	1·51

In examining the table which exhibits the composition of Chevalier barley we perceive considerable differences in the proportion of the principal ingredients; more especially is this the case with phosphoric acid, of which there is one-third more in No. 3 than in No. 1. The same remark applies, although in a less degree, to the analyses of Moldavian barley.

It is always to be expected that those kinds of grain which are surrounded by a silicious envelope should present far greater differences in mineral composition than naked seeds. In the latter case the organic matter is nearly homogeneous throughout; in the case of barley and oats we have a true seed with a thick silicious skin; and from differences in variety or in soil and climate, which may alter the relation in quantity between the seed and its envelope, must arise very great variation in the composition of the respective ashes. The following are analyses of two specimens of the straw of barley. By an oversight application was not made for the straws of the crops grown upon sand, until it was too late to obtain them:—

Barley Straw.

Per centage of water and ash in Moldavian Barley Straw:—

	Water.		Ash.		Ash calculated on dry substance.
Produce on clay	10·00	..	6·12	..	6·80
Sulphur on 1000 grains . .	1·56	..	..	..	..

The "awn" of the barley was burnt with the straw.

Composition in 100 parts of the ash of Barley Straw (grown on clay):—

	Moldavian Barley Straw.	Chevalier Barley Straw.
Silica	63·29	68·50
Phosphoric Acid . .	3·24	7·20
Sulphuric Acid . .	2·71	1·09
Carbonic Acid . . .	none.	none.
Lime	5·34	5·79
Magnesia	2·65	2·70
Peroxide of Iron . .	1·72	1·36
Potash	12·69	11·22
Soda	2·65	..
Chloride of Potassium .	..	..
Chloride of Sodium .	5·68	2·14
Total	99·97	100·00

In order to supply the vacancies in the above series, specimens of barley of the growth of the present year (1849) were collected for us by Mr. Frederick Eggar during a visit in Essex:—

Specimen No. 1. Chevalier Barley, grown by Mr. Nockolds, of Saffron Walden, on a deep loam soil with chalk subsoil.

Specimen No. 2. Chevalier Barley, grown on a chalk soil by Mr. Wilson, of Ickleton.

Specimen No. 3. Long-eared Nottingham Barley, grown on chalk soil, by Mr. Jonas, of Ickleton.

The samples were taken from the standing crops at harvest time, being cut off close to the ground.

Mr. Eggar carefully determined the relation of grain, straw, and chaff; and as these results may be of value for other purposes besides the comparison of the ash analyses, we subjoin them :—

Relative proportion of straw and chaff to grain in three specimens of Barley :—

	No. 1.	No. 2.	No. 3.
Grain	1000	1000	1000
Straw	985	1228	730
Chaff	167	184	200

For the ash analysis the straw and chaff were burned separately; but the analysis was made upon the ash of both mixed in the proper relative proportions.

Per centage of water and ash in Barley :—

	Water.			Ash.			Ash calculated on dry substance.		
	Grain.	Straw.	Chaff.	Grain.	Straw.	Chaff.	Grain.	Straw.	Chaff.
No. 1. Chevalier Barley on loamy soil . .	9·20	9·50	10·28	2·07	4·97	11·45	2·28	5·49	12·55
No. 2. Chevalier Barley on chalk . . .	11·16	8·58	10·81	2·13	3·34	6·18	2·39	3·65	6·93
No. 3. Long-eared Nottingham Barley on chalk	9·20	9·22	9·99	1·99	2·81	6·77	2·20	3·09	7·52

The per centage of ash in the *grain* is very similar for the three specimens, but in the straw and chaff the variation is considerable. The straw and chaff of No. 1 greatly exceed in quantity of mineral matter those of Nos. 2 and 3.

For analysis the straw and chaff ash were mixed in proper proportions; but, in order to understand the results, we must determine what per centage of ash the mixed straw and chaff would afford. This is easily ascertained by a calculation founded upon the relations of straw to chaff before given.

Without introducing the calculation here, it may be sufficient to give the results. The mixed straw and chaff contain—

No. 1.	No. 2.	No. 3.	
5·91	3·71	3·22	per cent. of ash.

Composition in 100 parts of the ash of Barley:—

	No. 1. Chevalier on loam.	No. 2. Chevalier on chalk.	No. 3. Long-eared Nottingham on chalk.	Mean of the three specimens.
Silica	18·41	17·27	21·12	18·93
Phosphoric Acid	38·78	30·76	29·92	33·15
Sulphuric Acid	trace.	·26	trace.	·09
Carbonic Acid	none.	none.	·48	·16
Lime	2·97	2·92	3·39	3·09
Magnesia	6·90	7·63	10·99	8·51
Peroxide of Iron	1·46	trace.	·15	·54
Potash	28·60	37·22	32·02	32·62
Soda	none.	none.	1·21	·40
Chloride of Potassium	1·29	1·93	. .	1·07
Chloride of Sodium	1·59	2·01	·72	1·44
Total	100·00	100·00	100·00	100·00

The *total* sulphur of 1000 grains of the undried barley was—

No. 1.	No. 2.	No. 3.
·74	1·83	1·41

Composition in 100 parts of the ash of Barley Straw (including the chaff):

	No. 1. Chevalier on loam.	No. 2. Chevalier on chalk.	No. 3. Long-eared Nottingham on chalk.	Mean of the three specimens.
Silica	62·79	48·18	52·40	54·45
Phosphoric Acid	4·22	3·41	2·13	3·25
Sulphuric Acid	2·22	3·18	3·04	2·80
Carbonic Acid	1·25	3·55	3·89	2·90
Lime	8·50	11·90	12·59	11·00
Magnesia	1·70	2·93	2·99	2·54
Peroxide of Iron	·20	·31	·32	·28
Potash	14·37	20·18	16·18	16·83
Soda	·28	3·29	none.	1·19
Chloride of Potassium	none.	none.	·90	·30
Chloride of Sodium	4·37	3·07	5·46	4·26
Total	100·00	100·00	100·00	100·00

The *total* sulphur on 1000 grains of the undried barley straw—

No. 1.	No. 2.	No. 3.
1·02	·54	1·15

The great difference which is observable in the *per centage* of ash of No. 1 also occurs in its *composition*: it contains nearly one-third more silica than No. 2. Not to dwell, however, on a question which these analyses are not expected to decide, we pass on to their legitimate application, namely, that of drawing out an average for the mineral composition of barley and barley-straw.

For this purpose all the specimens, including four reported in our first paper, will be grouped together without regard to soil or variety.

Average composition in 100 parts of the ash of Grain and Straw (with the chaff) of Barley:—

	Barley, mean of 13 specimens.	Barley Straw and Chaff, mean of 5 specimens.
Per centage of Ash . .	2·13	4·76
Silica	25·27	59·25
Phosphoric Acid . .	32·05	4·04
Sulphuric Acid . .	·95	2·45
Carbonic Acid . . .	·37	1·76
Lime	2·41	8·84
Magnesia	8·39	2·59
Peroxide of Iron . .	·76	·78
Potash	26·30	14·99
Soda	1·22	1·20
Chloride of Potassium .	·68	·18
Chloride of Sodium .	1·60	3·92
	100·00	100·00

The foregoing numbers may be safely taken as an *average* of the mineral composition of the barley crop. It only now remains to calculate from these data the effect of a crop of barley upon the mineral stores of the soil. 48 bushels of barley, at 55 lbs. to the bushel, will weigh 2640 lbs.; and allowing the straw and chaff to be $1\frac{1}{4}$ times the weight of the grain (or 3300 lbs.), which perhaps is a full proportion, the result will be as follows:—

Mineral matter removed from an acre of land, by a crop of barley, in lbs. and tenths:—

	In the Grain.	In the Straw and Chaff.	In the whole Crop.
Silica	14·2	93·0	107·2
Phosphoric Acid . .	18·0	6·3	24·3
Sulphuric Acid . .	·5	3·8	4·3
Carbonic Acid . . .	·2	2·8	3·0
Lime	1·6	14·0	15·6
Magnesia	4·7	4·1	8·8
Peroxide of Iron . .	·4	1·2	1·6
Potash	14·8	23·5	38·3
Soda	·7	1·9	2·6
Chloride of Potassium .	·3	·3	·6
Chloride of Sodium .	·9	6·1	7·0
	56·3	157·0	213·3

A glance at this table and that which was given for oats will at

once show the great similarity in their effect upon the soil, provided that the quantities which we have assumed for the different crops be at all in accordance with the truth.

Maize, or Indian Corn.—During the last twelvemonth* considerable attention has been attracted to the cultivation of maize, in consequence of the introduction of a new variety, which is said to be eminently adapted to the climate of this country. Mr. Keene, who has introduced this peculiar kind of Indian corn under the name of "Forty-day Maize," very obligingly placed a sufficient quantity of the different parts of the plant at our disposal for analysis. The following analyses exhibit the mineral composition of the grain, of the stalks with the leaves attached, and of the *pith* or centre of the "cobbs." Strictly speaking the analysis of the leaves should have been made separately, as Mr. Keene states that in the Pyrenees the leaves are stripped off whilst green and used as fodder for cattle.† The interest which attached to this examination is expressed in the following statement:—Land of average quality in a climate, according to Mr. Keene, very similar in many respects to that of the south of England, and which produces—say 30 bushels of wheat—gives on the average $5\frac{1}{2}$ or 6 quarters of Indian corn: the question arises, is there anything in the mineral composition of maize to lead us to believe that its larger production is dependent on more moderate mineral requirements than in the case of wheat? We will give the analyses of this plant, and then attempt to draw the comparison. The grain was burnt by itself, as was also the pith of the seed-head; the stalk of a plant was burnt with its accompanying leaves. It is open to question whether this latter specimen would afford a fair average of the produce of a whole field, but at the time the examination was made we were necessarily confined to the only specimens then to be obtained.

Per centage of water, ash, &c. in Keene's "Forty-day" Maize:—

	Water.	Ash.	Ash calculated on dry substance.	Sulphur on 1000 Grains undried.
Grain	9·25	1·37	1·51	2·05
Stalks and Leaves	8·82	5·01	5·49	4·58
Pith of the "Cobb" or seed-head	10·91	·50	·56	1·53

The ash of the pith is very small in quantity, being only 1-10th part that which is contained in the stem and leaves.

These ashes consist of the following ingredients:—

* October, 1849.

† This practice is of very questionable policy. The same thing has been done with turnips and beet on the Continent, but is condemned by the most distinguished agricultural writers of Germany and France.

Composition in 100 parts of the Ash of different parts of the "Forty-day" Maize :—

	Grain.	Stalks and Leaves.	Pith of the "Cobb."
Silica	1·55	27·98	26·35
Phosphoric Acid . .	53·69	8·09	4·37
Sulphuric Acid . .	traces.	5·16	1·92
Carbonic Acid . . .	none.	2·87	7·46
Lime	·57	10·53	3·43
Magnesia	13·60	5·52	4·06
Peroxide of Iron . .	·47	2·28	·22
Potash	28·37	35·26	42·26
Soda	1·74	none.	none.
Chloride of Potassium .	none.	. .	7·61
Chloride of Sodium .	traces.	2·29	2·28
	99·99	99·98	99·99

The first point to be noticed in the above table is that the phosphoric acid of the ash of the grain considerably exceeds that which is found in the ash of wheat, whilst the quantity of potash and of magnesia are very much the same in either case. The *mean* proportion of phosphoric acid in wheat ash is 45 per cent.—one specimen, however, having reached 49 per cent. On the other hand, Keene's maize only contains 1·37 per cent. of its weight of ash, whilst the mean mineral matter in the grain of wheat has been found to be 1·67 per cent. Whether the examination of further specimens of maize would establish a higher proportion of ash for its grain, we cannot say; it is quite possible that such might be the case, since in the analyses of wheat (given in the first report) we have recorded one instance in which 100 parts of wheat furnished only 1·36 parts of ash, although the mean proportion is 1·67 per cent. Mr. Keene has supplied us with some observations upon the different parts of the crop, which, taken in conjunction with the foregoing analyses, will make the relatively exhausting or non-exhausting character of maize a matter of easy calculation. On reference to his agricultural notes he finds that the aggregate crop is about from 2½ to 3 tons per acre, in the following proportions:—

	lbs.	
Dry leaves	937	2499
Envelope of the seed-head.	312	
Stalks with the roots	1250	
Pith of the seed-head	625	
Six quarters of grain, at 60 lbs. per bushel . .	2880	
Total . . .	6004 lbs.	

The weights were taken after three months' natural desiccation. It was precisely in this condition that the specimens were analyzed,

so that the numbers are capable of exact application. As before stated, in the analysis no separation was made of the leaves and stalks or the envelope of the seed, so that these three first items will be grouped together. The table below gives the quantity of mineral matter removed by an acre of "Forty-day" maize on the basis of Mr. Keene's calculations.

Mineral Matters removed by an acre of "Forty-day" Maize, in lbs. and tenths:—

	In 2880 lbs. of Grain.	In 625 lbs. of the Pith of the "Cobb."	In 2499 lbs. of Stalks and Leaves.	On the whole Crop.
Silica	·6	·82	35·0	36·4
Phosphoric Acid	21·2	·13	10·1	31·4
Sulphuric Acid	..	·06	6·4	6·5
Carbonic Acid	..	·23	3·6	3·8
Lime	·2	·10	13·2	13·5
Magnesia	5·4	·12	6·9	12·4
Peroxide of Iron	·2	·01	2·8	3·0
Potash	11·2	1·32	44·1	56·6
Soda	·7	·24	..	·9
Chloride of Potassium	..	..	..	..
Chloride of Sodium	..	·07	2·9	3·0
Total in lbs.	39·5	3·10	125·0	167·5

The second column of this table is chiefly interesting from the insignificance of the mineral matters removed by the pith of the cobbs. This part of the maize-plant is *relatively* small, but *actually* important in quantity. It is used, Mr. Keene informs us, by the peasants for firing, for which its light dry character well fits it. By the calculations above given, it would appear that every acre of maize would yield 5 cwt. of this fuel. In comparing the mineral composition of maize with that of wheat, we do not find the solution of the question lately proposed.

A crop of 28 bushels of wheat carries off, of phosphoric acid,—

In the grain	about	13 lbs.
In the straw	about	7 lbs.
In all		20 lbs.

And of potash:—

In the grain	about	9 lbs.
In the straw	about	14 lbs.
In all		23 lbs.

Whilst, on the other hand, what is said to be a fair crop of maize requires one-third more phosphoric acid and $2\frac{1}{2}$ times the quantity of potash. If then our data are correct, all notion of attributing the relative produce of the two plants to their mineral pecu-

liarities must be abandoned. We have elsewhere said that, as the most nutritive constituents of plants are in all cases accompanied by the scarce and consequently valuable minerals, it is of advantage to any particular vegetable produce that it should be high in the scale of mineral exhaustion, because, in the absence of direct examination of its vegetable composition, such a fact is in favour of its nutritive qualities. In this respect the grain of maize closely assimilates to that of wheat, and recorded analyses, as well as some which we have lately made, exhibit a close similarity in their nutritive characters.

Kohl Rabi.

The following are analyses of the bulb and leaves of this plant, the crop being grown by the Rev. A. Huxtable on the thin soil of the chalk downs of Dorsetshire.

Per centage of Water and Ash in the Bulb and Leaves of Kohl Rabi:—

	Water.	Ash.	Ash calculated on dry substance.
Bulbs	88·21	·95	8·09
Leaves	84·89	2·80	18·54

It is probable that the proportion of water in the recent specimen is rather higher than the above, as the plants had necessarily been exposed a considerable time before reaching the laboratory. The composition of the ash was as follows:—

Composition in 100 parts of the Bulb and Leaves of Kohl Rabi:—

	Bulbs.	Leaves.
Silica	·82	9·57
Phosphoric Acid	13·46	9·43
Sulphuric Acid	11·43	10·63
Carbonic Acid	10·24	8·97
Lime	10·20	30·31
Magnesia	2·36	3·62
Peroxide of Iron	·38	5·50
Potash	36·27	9·31
Soda	2·84	..
Chloride of Potassium	none.	5·99
Chloride of Sodium	11·90	6·66
Total	100·00	99·99

The above composition is in many respects similar to that of turnips, and does not require any special comment.

Carrots.

In our second report (Jour. R. A. S. E., vol. viii. part 1) will be found the analysis of White Belgian Carrots; but as this

variety is not so well known or so widely cultivated as the common red kinds, we have thought it necessary to examine the latter. The carrots were obtained from Mr. Paine, of Farnham, being the growth of 1847, of the sort called "Long Red Surrey," on poor but deep sand.

Per centage of Water and Ash in the Roots and Leaves of Red Carrots:—

	Water.	Ash.	Ash calculated on dry substance.
Roots	86·40	·74	5·44
Leaves	80·00	2·19	10·95

	Leaves.	Bulbs.
Sulphur on 1000 grains of undried specimens	·876	Not ascertained.

Composition in 100 parts of the ash of the roots and leaves of long red carrots:—

	Roots.	Leaves.
Silica	1·11	11·61
Phosphoric Acid	12·31	6·21
Sulphuric Acid	4·26	5·08
Carbonic Acid	18·00	23·15
Lime	5·64	24·04
Magnesia	2·29	·89
Peroxide of Iron	·51	3·43
Potash	43·73	17·10
Soda	12·11	4·85
Chloride of Potassium	none.	none.
Chloride of Sodium	traces.	3·62
Total	99·96	99·98

There is a sensible difference between the mineral composition of the Belgian carrots before analyzed and the present specimens of the common variety. But whether this difference is to be traced to the variety of the plant, or to any peculiarity in the soil, manure, or season, we have not the means of judging.

Cow-Cabbage.

The following is an ash analysis of a large variety of cattle cabbage, called the "Flatpole" or "Drumhead," for which we are indebted to the kindness of Mr. Fowler, of Dartmoor. The crop was grown upon newly-reclaimed land, well manured with cattle-dung. It was considered worth while to make a separate analysis of the head of the cabbage and the lower portion of the stalk.

Per centage of Water and Ash in Cow-Cabbage:—

	Water.	Ash.	Ash calculated on dry substance.
Leaves and upper portion of Stalk	93·01	·70	10·00
Lower portion of Stalk	—	1·24	—

Composition in 100 parts of Cow-Cabbage :—

	Cabbage.	Stalk.
Silica	1·66	1·04
Phosphoric Acid	12·53	19·57
Sulphuric Acid	7·27	11·11
Carbonic Acid	16·68	6·33
Lime	15·01	10·61
Magnesia	2·39	3·85
Peroxide of Iron	·77	·41
Potash	40·86	40·93
Soda	2·43	4·05
Chloride of Potassium	none.	..
Chloride of Sodium	traces.	2·08
Total	99·99	99·98

The *total* sulphur in 1000 grains of undried cabbage is ·63.

The principal differences between the stalk and the main body of the plant consist in the much larger per centage of ash in the former, and the greater quantity of phosphoric acid contained in the ash.

Rape.

The following specimen of green rape was grown upon good wheat land, being sown in the beginning of July. When analyzed it was about 15 inches high.

Water, Ash, and Sulphur in Green Rape :—

Water	86·96
Ash	1·30
Do. calculated on dry substance	9·98
Sulphur on 1000 grains undried	1.03

Composition of 100 parts of Green Rape :—

Silica	6·28
Phosphoric Acid	6·85
Sulphuric Acid	15·91
Carbonic Acid	10·96
Lime	9.96
Magnesia	2·48
Peroxide of Iron	1·58
Potash	26·00
Soda	—
Chloride of Potassium	8·91
Chloride of Sodium	11·02
Total	99·95

Gorse.

The green cuttings of Gorse give on analysis the following results :—

Per centage of Water and Ash in Gorse :—

Water	40·58
Ash	2·15
Do. calculated on dry substance	3·62

Composition in 100 parts of the Ash of Gorse:—

Silica	5·97
Phosphoric Acid	8·78
Sulphuric Acid	5·70
Carbonic Acid	13·88
Lime	28·32
Magnesia	8·16
Peroxide of Iron	2·12
Potash	18·93
Soda	none.
Chloride of Potassium	3·64
Chloride of Sodium	4·50
Total	100·00

Hops.

In a former Report (Journal of the Royal Agricultural Society, vol. ix. part 1) we gave the analyses of three specimens of the flower of hops—not having at that time the opportunity of procuring satisfactory specimens of the bine and leaves, the examination of these latter was deferred: the omission is now supplied. The specimens described were collected by Mr. Frederick Eggar, being grown on the property of Mr. Samuel Eggar, of Bentley, near Farnham. The soil is a grey speckled loam, immediately below the upper greensand, of great fertility, and which has been cultivated in hops for two or three centuries; the specimens were collected with the greatest care and dried in the kiln by themselves at a temperature of about 150° Fahr.* The hops are the growth of 1848 and of the variety called the "Golding."

Per centage of Water and Ash, and Sulphur in 1000 parts of the Flower, Bine, and Leaves of Hops, after drying at 150° Fahr.:—

	Flowers.	Leaves.	Bine.
Water	13·00	11·80	10·40
Ash	7·85	19·35	6·52
Ditto calculated on dry substance	9·00	21·94	7·28
Sulphur on 1000 grs. undried	8·13	6·49	2·71

Composition in 100 parts of the Ash of the Flowers, Leaves, and Bine of Hops.

	Flowers.	Leaves.	Bine.
Silica	19·16	22·35	9.99
Phosphoric Acid	17·33	9·33	11·69
Sulphuric Acid	5·10	1·89	2·33
Carbonic Acid	1·92	12·04	11·92
Lime	9·59	30·78	23·71
Magnesia	4·80	4·84	3·77
Peroxide of Iron	·68	·19	·80
Potash	31·70	13·13	17·60
Soda	..	..	..
Chloride of Potassium	8·96	2·29	15·55
Chloride of Sodium	·74	3·12	2·63
Total	99·98	99·96	99·99

* The use of sulphur was avoided in drying the specimens.

The hop plant, it appears, is peculiar in the quantity of phosphoric acid required for all its different parts; in this respect it far exceeds any other plant which we have examined. It may not be without reason, therefore, that the value of land which is devoted to hops has been referred to the great prevalence in it of phosphate of lime. The chemical history of the greensand district, which is principally cultivated in hops, has been fully given in this Journal (vol. ix. part 1, Phosphoric strata of the Chalk Formation); and it is interesting to observe that the composition of the hop is such as to bear out the views which were there advanced.

A calculation of the mineral matters removed from an acre of land by the crop from which the specimens were taken, will serve to exhibit the exhausting character of its culture in relation to other plants.

The produce of two hills of fair average was collected—the hills being six feet apart, or 1200 hills to an acre.

The following table shows the quantity of produce and of mineral matter removed per acre after drying at 150°:—

	Produce from 2 Hills.	Produce per Acre.	Mineral Matter per Acre.
	lbs.	lbs.	lbs.
Flowers	3·5	2131	170·43
Leaves	3·75	2250	435·06
Bine	3·25	1987	129·54

It will be here observed that the produce in hops is made by the experiment on the two hills to equal nearly a ton per acre; in effect this number is verified by the result on the large scale—the quantity of hops obtained from 23 acres having been 19 tons.

The crop of 1848 was almost unprecedentedly large, which must be ever borne in mind in the consideration of the table which precedes as well as that which follows.

TABLE showing the quantity of Mineral Matter removed by the above crop of Hops, in lbs. and tenths.

	Flowers.	Leaves.	Bine.	Whole Crop.
	lbs.	lbs.	lbs.	lbs.
Silica	32·6	97·3	12·9	142·8
Phosphoric Acid	29·5	40·6	15·1	85·2
Sulphuric Acid	8·7	8·2	3·0	19·9
Carbonic Acid	3·4	52·4	15·4	71·2
Lime	16·3	134·0	31·0	181·3
Magnesia	8·2	21·1	4·9	34·2
Peroxide of Iron	1·1	·8	1·0	2·9
Potash	54·0	57·0	22·9	133·9
Soda	none.	none.	none.	none.
Chloride of Potassium	15·3	10·0	19·9	45·2
Chloride of Sodium	1·3	13·6	3·4	18·3
Total	170·4	435·0	129·5	734·9

Were the numbers in this table applicable to the ordinary

produce of hops, we should have no hesitation in classing it amongst those requiring the highest amount of mineral matters. We have already stated that the produce of 1848 was unusually great,* and the *average* produce of good hop land cannot be placed at more than 6 or 7 cwt. per acre. A simple division of the foregoing numbers by 3 will therefore give the ordinary mineral exhaustion by hop cultivation.

The attentive reader will, from the aggregate mineral matters of the bine and leaves, be at once sensible of the great necessity of their careful preservation and restoration to the soil in manure or otherwise. He will also be led to inquire how far, in ordinary practice, he compensates for the large draughts of phosphoric acid and potash which, by the perpetual cultivation of hops, he is yearly making upon the stores of the soil.

Seeds of Turnip, Mangold, Carrot, &c.—The following are analyses of the seeds of some commonly cultivated plants, obtained from Messrs. Gibbs, of Half-Moon Street:—

Per eentage of Water and Ash in Various Seeds :—

	Water.	Ash.	Ash calculated on Dry Substance.	Sulphur on 1000 Grains undried.
Long Red Surrey Carrot Seed	13·00	8·73	10·03	3·05
Sainfoin Seed . . .	16·00	4·43	5·27	3·33
Italian Rye-Grass Seed	11·70	6·10	6·91	3·06
Orange-globe Mangold-wurzel Seed . . .	11·66	5·83	6·58	·90
Norfolk White Turnip Seed	7·70	3·67	3·98	8·85
White Mustard Seed .	8·50	4·07	4·45	12·12

Composition in 100 parts of the Ash of Various Seeds :—

	Carrot Seed.	Sainfoin Seed.	Italian Rye-Grass Seed.	Mangold-Wurzel Seed.	White Mustard Seed.	Turnip Seed.
Silica	4·50	·71	50·55	1·86	1·31	·67
Phosphoric Acid .	13·38	20·74	17·89	13·35	44·97	40·17
Sulphuric Acid .	4·80	2·81	2·31	3·64	2·19	7·10
Carbonic Acid . .	15·13	13·25	·44	13·85	. .	·82
Lime	32·96	27·39	9·98	13·42	19·10	17·40
Magnesia	5·70	5·77	5·26	15·22	5·90	8·74
Peroxide of Iron .	·84	1·38	2·36	·40	·39	1·95
Potash	16·21	24·75	9·51	16·08	25·78	21·91
Soda	1·23	1·46	·06	6·86	·33	1·23
Chloride of Potassium	none.	none.	none.	none.	none.	none.
Chloride of Sodium	5·24	1·73	1·62	15·30	traces.	traces.
	99·99	99·99	99·98	99·98	99·97	99·99

* We are informed by Mr. Paine that this year's yield of hops on his land will, on the average of the whole of his extensive plantations, very closely approximate to the above high estimate.—October, 1850.

The ripening of the seed of a plant is very generally believed to cause a far greater exhaustion of the nutritive matters of the soil than any previous stage of its growth. By some this effect has been ascribed to the mineral matters which the seed requires, and which are always of a more valuable character than those which are found in other parts of the plant. Without attempting to offer any opinion on this question at present, we may point to these analyses as proof of the uniform existence of these more important substances in the ashes of all seeds. The *per centage of ash* in the above instances is so very variable as to hide in a great measure the significance of its composition in different seeds.

For example, the ash of carrot-seed contains only 13 per cent. of phosphoric acid, whilst that of wheat gives 45 per cent. of the same ingredient. On the other hand, the per centage of ash in wheat being 1·67, that of carrot-seed is 8·73, or 5 times as great; so that in reality, in a *given weight* of the two seeds, that of the carrot contains by far the most phosphoric acid.

Flax.

Although the cultivation of flax is by no means extended in this country, and a knowledge of its composition is on this account of less immediate interest to the bulk of farmers, the peculiarity of the crop and the great commercial importance which it possesses in a manufacturing country like England, have, for the last few years, drawn to the *principles* of flax culture a considerable share of attention.

The greater part of the *exact* knowledge which we at present possess of the composition of the flax plant, is due to the admirable researches of Sir Robert Kane, who first drew attention to the ruinous and unnecessary waste which took place in the then practised methods of steeping. Sir Robert Kane's conclusions have been on more than one occasion brought into question, although the objections raised against them cannot be said to apply with any degree of truth to the *spirit*—hardly indeed to the *letter*—of his assertions; but with the exception of this trifling opposition, the views which the above-named chemist first advanced have been generally adopted, upon a full belief of the correctness of the analyses upon which they were founded. Some recent analyses of flax, by Messrs. Mayer and Brazier,* have corroborated Dr. Kane's results, so far as regards the composition of the plant as it leaves the field, although they do not furnish any further information on the points which have been in dispute.

It appeared to us that by following a distinct method of in-

* 'Quarterly Journal of the Chemical Society of London,' No. 5.

quiry, and instituting a minute examination of every part of the plant, we should supply an unanswerable proof of the truth or error of Sir Robert Kane's conclusions, and at the same time enable the farmer to make the most profitable use of the various products which are obtained in the course of preparation which flax undergoes before being sent to market.

With the view of obtaining specimens of known growth and judicious preparation, we applied to Mr. Warnes, of Trimingham, whose disinterested exertions in the flax cause are well known. To his active courtesy we owe much of the information upon which our calculations are based, as well as the specimens whose analysis is here given. The analyses will first be introduced, and we shall afterwards proceed to show to what conclusions they tend.

Per centage of Water, Ash, and Sulphur in Flax Straw :—

	No. 1. Fine Flax Straw, Mr. Warnes.		No. 2. Coarse Flax Straw, Mr. Warnes.
Water	11·60	..	20·71
Ash	3·27	..	4·01
Ash calculated on the dry substance	3·70	..	5·01
Sulphur on 1000 grains of the undried specimen	1·38	..	2·00

The composition of the ash is given in the following table :—

Composition in 100 parts of the Ash of Fine and Coarse Flax Straw :—

	No. 1. Fine Flax Straw, Mr. Warnes.	No. 2. Coarse Flax Straw, Mr. Warnes.
Silica	7·92	5·60
Phosphoric Acid . .	7·53	8·48
Sulphuric Acid . .	3·39	4·99
Carbonic Acid . . .	15·75	13·39
Lime	21·20	15·87
Magnesia	4·20	3·68
Peroxide of Iron . .	5·58	4·84
Potash	21·53	34·96
Soda	3·68	..
Chloride of Potassium .	..	7·65
Chloride of Sodium .	9·21	·53
Total	99·99	99·99

No. 1 is the *entire straw* of fine flax grown by Mr. Warnes, of about 2 feet 8 inches in length, and yielding a fibre of excellent fineness and strength. The crop was grown in 1847, upon good friable loam after clover, which had been down one year (flax

being substituted in the six-course system for the second year's seeds); it was partly manured with box-manure.

No. 2 is the entire straw of very luxuriant flax, averaging 4 feet in length, and giving a very coarse fibre, also grown by Mr. Warnes.

The straws are in each case divested of the *husk* or seed envelope, but in every other respect in the state in which they left the field.

By these analyses we are led to believe that *coarse* flax not only removes from the soil a greater amount of ash than a finer specimen of the plant, but that the ash contains a higher per centage of potash than that of fine flax. Further on will be found a comparison of the two specimens in this particular.

We next exhibit the analyses of two specimens of linseed, of which No. 3 was the produce of the specimen of fine flax just described. No. 4 was grown by H.R.H. Prince Albert at the farm in Windsor Park,* the flax which produced it being of a very luxuriant character.

Per centage of Water, Ash, and Sulphur, in Linseed:—

	No. 3. Mr. Warnes.		No. 4. H.R.H. Prince Albert.
Water	12·33	..	11·60
Ash	2·68	..	3·30
Ash on dry substance .	3·05	..	3·68
Sulphur on 1000 grains of undried specimen	2·30	..	1·60

The composition of the ash being as follows:—

Composition in 100 parts of the Ash of Linseed:—

	No. 3. Mr. Warnes.	No. 4. H. R. H. Prince Albert.	Mean of the two Analyses.
Silica	1·46	1·45	1·45
Phosphoric Acid . .	35·99	41·09	38·54
Sulphuric Acid . .	1·43	1·69	1·56
Carbonic Acid . . .	..	·43	·22
Lime	9·45	7·35	8·40
Magnesia	16·23	9·99	13·11
Peroxide of Iron . .	·38	·61	·50
Potash	32·55	35·79	34·17
Soda	2·51	·88	1·69
Chloride of Potassium .	..	..	..
Chloride of Sodium .	trace.	·72	·36
Total	100·00	100·00	100·00

The ash of linseed is evidently of the richest character; in composition it nearly approaches that of wheat, whilst in *quantity* it

* Major-General Wemyss was good enough to send this specimen to the laboratory at the request of Mr. Warnes.

greatly exceeds the latter grain. In addition to the stalks and the seed there are two other parts of the flax plant of no small degree of importance—the leaves, which more or less fall from the flax before it is pulled, and the *bolls* or *husks* (the envelope of the seed), which are separated with the latter in the process of rippling or beating.

The husks and leaves of which the analysis is given below, were from the fine flax of Mr. Warnes' crop before described.

Per centage of Water, Ash, and Sulphur, in the Husks and Leaves of fine Flax:—

	Husks.		Leaves.
Water	13·33	..	12·66
Ash	6·39	..	7·72
Ash on dry substance . . .	7·37	..	8·83
Sulphur on 1000 grains of the undried specimens . .	2·01	..	1·21

Composition in 100 parts of the Ash of the Leaves and Husks of Flax:—

	No. 5. Husks.	No. 6. Leaves.
Silica	15·43	25·93
Phosphoric Acid . .	2·61	3·41
Sulphuric Acid . .	4·26	3·66
Carbonic Acid . . .	10·15	9·76
Lime	26·60	29·87
Magnesia	2·50	2·80
Peroxide of Iron . .	2·02	3·24
Potash	25·80	16·04
Soda	..	..
Coloride of Potassium .	3·37	5·28
Chloride of Sodium .	7·26	..
Total	100·00	99·99

The foregoing analyses afford us the data for calculating the immediate effect that the flax crop would produce upon the mineral stores of the soil.

As in all other crops, however, one portion of the flax is, in the ordinary course of farm practice, returned to the soil in manure, whilst another part goes off permanently to market, we therefore require further to know how, in the case of flax, this distribution occurs.

When flax is becoming ripe the greater part of its *leaves* fall off and are left on the land.

At a convenient time the grower separates the seed from the straw by rippling or beating it. From the seed the capsule or *husk* is separated by an ordinary winnowing-machine.

The seed is used for feeding cattle, or it may in some cases be sold; the husks are used also in the same manner as hay; the

cattle relish them, and Mr. Warnes considers them, weight for weight, equal to good hay.

But in flax the straw is destined to a more important purpose than that of any of the corn-crops, and the chemist who would wish to make out its history must follow it through the processes, having this purpose in view.

After the separation of the seeds the stalks are steeped for a certain length of time in water, a species of fermentation is produced, and the woody matter of the straw becomes rotten and detached from the fibre; at this juncture the stalks are removed and spread upon the grass to *bleach*. Subsequently, in the operation of *scutching*, the *woody matter* is separated from the *fibre*—the all-important part of the plant—by a simple mechanical process.

It is necessary that we should know first how much of the mineral matter of the stalks is lost or removed in the steeping; and next, of that which remains, what proportion is left on the farm in the wood, and what permanently removed by being sent to market.

Specimen No. 7 is the straw of fine flax (No. 1) after steeping; No. 8 is the fibre, and No. 9 the wood, separated from No. 7.

Per centage of Water, Ash, and Sulphur, in Fine Flax Straw after steeping, and in the Fibre and Wood of the same :—

	No. 7. Fine Flax Straw, steeped.		No. 8. Fibre of Ditto.		No. 9. Wood of Ditto.
Water	13·18	..	7·91	..	12·60
Ash	·97	..	1·03	..	·84
Ash calculated on dry substance	1·11	..	1·12	..	·95
Sulphur on 1000 grains undried . . .	·21	..	2·43	..	·76

Composition in 100 parts of the Ash of Fine Flax Straw, steeped, and of the Wood and Fibre of the same :—

	No. 7. Fine Flax Straw, steeped.	No. 8. Fibre of Ditto.	No. 9. Wood of Ditto.
Silica	15·96	5·08	2·96
Phosphoric Acid . .	3·79	10·76	5·12
Sulphuric Acid . .	1·90	2·66	4·68
Carbonic Acid . . .	18·04	17·76	28·68
Lime	47·00	48·75	40·46
Magnesia	2·60	4·43	2·77
Peroxide of Iron . .	5·68	3·54	2·45
Potash	1·70	1·92	9·00
Soda	3·33	3·80	3·88
Chloride of Potassium .	..	..	..
Chloride of Sodium .	trace.	1·30	trace.
Total	100·00	100·00	100·00

In addition to the fibre of the fine flax, we have examined two

other specimens of coarse fibre; No. 10 being the produce of Mr. Warnes' luxuriant flax (No. 2), and specimen No. 11 being the growth of H.R.H. Prince Albert.

Per centage of Water, Ash, and Sulphur, in two specimens of Coarse Flax Fibre:—

	No. 10. Mr. Warnes.		No. 11. H.R.H. Prince Albert.
Water	8·76	..	13·00
Ash	·69	..	·52
Ash calculated on dry substance .	·76	..	·60
Sulphur on 1000 grains of undried specimen .	2·13	..	·62

Composition in 100 parts of the Ash of Coarse Flax Fibre:—

	No. 10. Mr. Warnes.	No. 11. H. R. H. Prince Albert.
Silica	6·18	3·92
Phosphoric Acid . .	4·94	11·86
Sulphuric Acid . . .	3·81	trace.
Carbonic Acid . . .	22·05	14·45
Lime	51·58	51·56
Magnesia	·27	8·47
Peroxide of Iron . .	3·08	5·29
Potash	4·47	1·71
Soda	·62	2·21
Chloride of Potassium .	..	..
Chloride of Sodium .	..	·43
Total	100·00	100·00

In the analyses here given of the different parts of flax, one observation occurs to us as applying to all—namely, the large proportion of peroxide of iron. Oxide of iron is always present in small quantity in the ashes of plants, although for the most part it is limited to 1 or 1½ per cent. In the preceding analyses the proportion is found in several cases to reach 5 per cent.; that it is not derived from the steep water is plain, because the unsteeped flax contains it; that the soil has not given rise to the peculiarity may be inferred from the fact that the specimen grown by H.R.H. Prince Albert contains as much iron as those grown in Norfolk by Mr. Warnes. Is the oxide of iron in any way of more importance to the flax plant than to other vegetables? This question we are unable to answer satisfactorily; but in the meanwhile it may not be amiss to have called attention to the fact of its pervading the entire plant with the exception of the seed.

Without dwelling on the analyses of individual parts of the flax plant we shall proceed at once to employ them in calculating the effect of flax culture upon the mineral supplies of the soil. The produce of flax is very variable, being greatly affected by the kind of soil and the quantity of seed which is sown. It would

appear best in the present place to employ the data which apply to the actual specimens upon which the examination has been made. Mr. Warnes considers that an acre of good average loam will produce from 40 to 45 cwt. of flax straw, neither *very* fine nor coarse, with from 20 to 28 bushels of linseed, and about 9 cwt. of *bolls*, or the woody envelope of the seed. To those who may think this quantity of seed too high, it may be answered that Mr. Warnes does not consider it necessary to sacrifice the seed to the fibre, and that he finds it perfectly practicable to obtain a fair return of seed at the same time that he secures a fibre of good quality.

That the produce in seed of Mr. Warnes' crop is such as above stated, was made evident to one of us by an experiment on the small scale performed at Trimingham on the crop of 1847.

Some average bundles of fine flax, from which the seed had not yet been removed, were placed upon a cloth on the barn-floor, the seed being then beaten out in the usual way.

The quantity operated upon weighed altogether 95 lbs., and was found to yield—

	lbs.
Flax Stalks	61
Seed	$20\frac{1}{2}$
"Bolls" (seed-vessels) and Leaves	$13\frac{1}{2}$

The seed was here, therefore, one-third of the weight of the stalks. Supposing the seed to weigh 56 lbs. to the bushel, which good seed will do (and which is a convenient datum, as being just $\frac{1}{2}$ cwt.), and further supposing that the produce of stalks, when divested of the seed, is taken at 2 tons, the quantity of seed would be something above 26 bushels to the acre. In the calculations that follow, the produce in seed has, for the sake of avoiding dispute, been estimated only at 20 bushels to the acre, or one-fourth of the weight of the stalks.

The experiment just described fixes the quantity of *husks*, or bolls, at about $8\frac{3}{4}$ cwt. per acre. From other and practical results Mr. Warnes considers it to average 9 cwt. per acre, a number which may therefore be taken as correct.

Assuming then that an acre of good land in flax will produce

2 tons of Flax Straw,
20 bushels of Seed (weighing, at 56 lbs. per bushel, 10 cwt.),
9 cwt. of *bolls* or husks,

and leaving out of the calculation the leaves, the greater part of which fall off and are left on the land, we may by an easy calculation arrive at the *immediate* exhaustion of mineral matters which is produced by the growth of this crop. By *immediate* exhaustion we refer to that amount of mineral matter which must be furnished by the soil and manure to enable the crop to come to

perfection, and contradistinguished from the *ultimate* exhaustion, which is regulated by the proportion of these matters eventually restored in the manure into which they are converted.

40 cwt. of fine flax straw at 3·27 per cent. of ash will contain 146·5 lbs. of ash.
10 cwt. of seed at 2·99 per cent. of ash (which is the mean per centage of the two specimens examined) will contain 33·5 lbs. of ash.
9 cwt. of *bolls* or husks at 6·39 per cent. of ash will contain 64·4 lbs. of ash.

These ashes will consist respectively of the following mineral matters:—

Mineral Matters in lbs. and tenths removed by an Acre of Flax:—

	In 2 tons of Flax Straw.	In 20 bushels of Linseed.	In 9 cwt. of Bolls.	In the entire Crop.
Silica	11·6	·5	10·0	22·1
Phosphoric Acid . .	11·0	12·9	1·7	25·6
Sulphuric Acid . .	5·0	·5	2·7	8·2
Carbonic Acid . . .	23·1	. .	6·5	29·6
Lime	31·1	2·8	17·2	51·1
Magnesia	6·1	4·4	1·6	12·1
Peroxide of Iron . .	8·2	·2	1·3	9·7
Potash	31·5	11·4	16·6	59·5
Soda	5·4	·6	. .	6·0
Chloride of Potassium .	. .	. .	2·2	2·2
Chloride of Sodium .	13·5	·2	4·6	18·3
Total	146·5	33·5	64·4	244·4

The *immediate* effect of such a crop in exhausting the mineral matters of the soil in which it grows, is then (in all ingredients save silica) considerably greater than that of any of the corn-crops—it contains one-fourth more phosphoric acid and twice as much potash as an average acre of wheat—this circumstance is doubtless important as a guide in *preparing* the land for the growth of the flax, but it will have no further objectionable import if it can be shown that, in the ordinary course, the greater part of the mineral matter is (or readily might be) restored to the soil. The term *exhaustion*, in reference to mineral matters, can have no real meaning in such a case. Is it ever objected to a crop of turnips or mangold that they are exhausting? and yet both of these plants take from the soil twice the quantity of important minerals that a wheat or barley crop would. But being in great part or entirely consumed on the land, or at all events remaining upon the farm, and being eventually returned in the shape of manure, the phosphoric acid and potash (with certain exceptions) are really not removed—the land is really not exhausted of them.

The mineral matters of the linseed and of the seed-capsules find their way readily back to the soil in the shape of manure. It remains now to trace those which are contained in the flax-

straw. The flax-straw in steeping loses very considerably in weight; and for our present calculation it is necessary to know what this loss is. Mr. Warnes finds the loss in steeping to amount to very nearly one-third of the original stalks. On this datum 2 tons of straw, the produce of an acre, would, after steeping and drying, be reduced to about 27 cwt. or more, exactly 4480 lbs. would become 3020 lbs. In such cases as this a *practical* result is of more importance than that of any experiment on the small scale, but if additional confirmation of a fact is obtained by such a means, there can be no reason why we should reject it. It occurred to us that having abundant specimens of the same crop before steeping and after that process, we might arrive with tolerable correctness at the loss of weight in steeping, by weighing *a given number* of straws in both conditions; a quantity of steeped and unsteeped straw, as nearly as might be of an average degree of fineness, was selected, the straws being *counted* and weighed.

Of the unsteeped—

			Grains.
1st Experiment,	1000 straws weighed	. . . . . .	3720
2nd Ditto	ditto	. . . . . .	3241
Mean weight of 1000 straws unsteeped		. . . . .	3482

Of the steeped—

1st Experiment,	1000 straws weighed	. . . . . .	2445
2nd Ditto	ditto	. . . . .	2403
Mean weight of 1000 straws steeped		. . . . . .	2424

These figures would indicate about 30 per cent. as the loss of weight in steeping. This experiment was made before we had ascertained that the loss was estimated in the practical way at one-third, and allowing for all the imperfections to which it is liable, it sufficiently confirms Mr. Warnes' calculation.

With this information we proceed to inquire what occurs in the process of steeping; it is obvious that by deducting the mineral matter contained in 26 cwt. of steeped flax from that contained in 40 cwt. of unsteeped, the quantity remaining in the steeped water in which the produce of an acre has been *retted* will at once be obtained.

100 parts of fine flax stalks contain (Analysis No. 1) 3·27 parts of ash; 4480 lbs. (2 tons) will therefore contain 146·32 lbs. of mineral matters.

100 parts of the same flax after steeping contain only 0·97 per cent. of ash; consequently 3020 lbs. (which is two-thirds of 2 tons) will contain 29·3 lbs. of ash.

The following table exhibits the composition of these ashes—the third column indicating the amount of mineral matters separated in the steep-water:—

	In 4480 lbs. (2 tons) Unsteeped.	In 3020 lbs. of Steeped.	Lost in the Steep-Water.
Silica	11·60	4·67	6·93
Phosphoric Acid . .	11·04	1·11	9·93
Sulphuric Acid . .	4·27	·55	4·42
Carbonic Acid . . .	23·00	5·29	17·71
Lime	31·01	13·77	17·24
Magnesia	6·15	·76	5·39
Peroxide of Iron . .	8·11	1·66	6·45
Potash	31·55	·50	31·05
Soda	5·39	·98	4·41
Chloride of Potassium .	..	..	..
Chloride of Sodium .	13·50	..	13·50
Total	146·32	29·29	117·03

This table, although in substance it is merely a confirmation of what Sir Robert Kane has so well shown before, cannot yet be studied without renewed interest. By an examination of a certain specimen of flax-straw before steeping, and a portion of the same specimen after undergoing that process, we discover a difference or loss of four-fifths of the whole mineral ingredients; this loss consisting principally, as it naturally would, of the soluble and most important constituents.

Nearly all the potash, the magnesia, and the phosphoric acid have disappeared, whilst what is left is little else than carbonate of lime with a little silica and oxide of iron. It is needless to insist therefore upon what has so often before been said, that as in the steep-water will be found the great bulk of the mineral matters with* one-third of the vegetable matter of the straw (and this too, according to Dr. Kane, very rich in nitrogen), every effort should be made for the introduction of such modifications of the process as will allow of their return to the soil in some form or other.

We beg the reader to follow us one step further whilst we show from the analyses what becomes of the mineral matters which are still left in the steeped straw. In the "scutching" the fibre of the flax is separated from the wood by striking the straw with a peculiarly shaped piece of wood; no chemical change intervenes in this case, and there is therefore no loss of mineral ingredients.†

* From certain analyses of *flax-water* made since the above was written, I have reason to think that a large portion of the vegetable matter which the flax loses in steeping is dissipated by the fermentation; at all events, the steep-water contains much less than it should do were such not the case.—J. Thomas Way, October, 1850.

† Unless indeed the very considerable dust which is produced in the operation, and which is annoying to the eyes of any person entering the room where the scutchers are at work, should be in part composed of silicious matter, a circumstance which is not improbable.

The products of the scutching process are the fine flax fibre—the fine tow, which consists of the former twisted, broken, and tangled, but otherwise the same in composition—and the coarse tow, which is a mixture of fine tow with a certain quantity of wood; these three, with the wood itself, are all the products arising from the scutching.

An experiment, on the small scale, made at Trimingham, gave the following numbers as representing the proportions of each product:—

14 lbs. of the fine flax, steeped, being scutched, produced

$46\frac{1}{2}$ oz. of fine flax fibre	. . . .	or 21 per cent.
$2\frac{1}{2}$ oz. of fine tow $13\frac{3}{4}$ oz. of coarse tow	}	or 7 per cent.
$161\frac{1}{4}$ oz. of wood	. . . .	or 72 per cent.

Mr. Warnes, amongst other experiments, has mentioned to us one in which 25 cwt. of steeped flax yielded 5 cwt. 2 qrs. 6 lbs. of fine fibre, which is as nearly as possible 21 per cent., and agrees accurately with the determination before given. Allowing the quantity of flax of inferior strength or necessarily destroyed in the scutching, that is to say the fine and coarse tow, to be about the same in the hands of any one workman at different times, we shall have 72 per cent. as the proportion of wood. This number, being probably very nearly true, will be adopted: 3020 lbs. of steeped stalks will, upon this showing, produce in the scutching,—

2174 lbs. of wood,
634 lbs. of fibre,
212 lbs. of fine and coarse tow.

It is obvious that, by the deduction of the mineral matter of the wood from that of the steeped stalks, that of the other products would be obtained, or *vice versâ*. We have some reason to doubt the wood which was analyzed having been produced from the same crop, both from its composition and because it was not collected at the same time; it will therefore be better to deduct the ash of the fibre, of which we know the history, from that of the steeped straw which produced it; for this purpose the fine and coarse tow will be considered to have the same composition as the fine fibre, which it would have but for the small quantity of wood mixed with the coarse tow; any error introduced from this source will be too small to affect the result in an appreciable degree.

The table which follows gives the ultimate distribution of the mineral substances which have survived the process of steeping.

	In 3020 lbs. of Steeped Flax.	In 846 lbs of Fibre, and Fine and Coarse Tow.	In 2174 lbs. of Wood.
Silica	4.67	·44	4·23
Phosphoric Acid . .	1·11	·94	·17
Sulphuric Acid . .	·55	·23	·32
Carbonic Acid . . .	5·29	1·57	3·72
Lime	13·77	4·24	9·53
Magnesia	·76	·38	·38
Peroxide of Iron . .	1·66	·31	1·35
Potash	·50	·17	·33
Soda	·98	·33	·65
Chloride of Potassium .	. .	. .	. .
Chloride of Sodium .	. .	·11	. .
Total	29·29	8·72	20·68

Here then is a further reduction of the mineral matters of the flax-plant considered in relation to its industrial applications. Of the comparatively small proportion of ash remaining in the steeped straw little more than one-fourth belongs to the fibre, the other three-fourths being found in the wood. The wood, which is a large product of flax growing, is used for litter and other purposes to which straw is applicable, and its mineral matters find their way in due course back to the fields. We shall sum up the foregoing calculations in a few words.

A crop of fine flax, consisting of 40 cwt. of stalks, 20 bushels of seed, and 9 cwt. of the seed-capsules and leaves, contains 244·4 lbs. of mineral matters. Of these there is found

	lbs.		lbs.
In the seed	33·5	. . . .	33·50
In the seed capsules	64·4	. . . .	64·40
In the straw	146·5 of which	In the steep water	117·03
		In the wood . .	20·68
		In the fibre and tow	8·72

Of this 118·58 lbs. is actually returned to the soil in the seed, the husks, and the wood; another quantity of 117·03 lbs. *may be* restored in the steep water, and only 8·72 lbs. of mineral matter is necessarily lost to the farm in the fibre.

Leaving out the less important constituents, the following will be the distribution of silica, phosphoric acid, magnesia, and potash :—

	Silica.	Phosphoric Acid.	Magnesia.	Potash.
	lbs.	lbs.	lbs.	lbs.
In the Seed	·50	12·90	4·40	11·40
In the Seed Capsule .	10·00	1·70	1·60	16·60
In the Steep-water . .	6·93	9·93	5·39	31·05
In the Wood . . .	4·23	·17	·38	·33
In the Fibre and Tow .	·44	·94	·38	·17
Total	22·10	25·64	12·15	59·55

The examination of this table cannot fail to convince every reasonable person that the flax-plant, considered *in relation to mineral matters only*, is not necessarily an exhausting crop; on the contrary, that with the use of a proper system in the employment of the seed and the steeping of the straw, it is one of the crops which least exhausts the mineral contents of the soil; for it may be confidently asked, what vegetable produce sent to market is there that from an acre of land carries with it so little as 1 lb. of phosphoric acid and two-tenths of a lb. of potash? Whilst, however, it is confidently asserted that flax-culture is not, when properly managed, half so *minerally exhausting* as that of any other crop, we must be held excused for not expressing any opinion as to whether, in a *general sense,* flax is or is not exhausting; and the more so that at present no certain knowledge exists of the cause, or *modus operandi* of the cause, producing the results to which, in agricultural language, this title has been given.

Potatoes.

During the ravages of disease to which this crop has been exposed, it has seemed almost useless to expend upon its ash analysis any great amount of labour, inasmuch as the results could never be said with safety to apply to the normal or healthy condition of the plant.

Not wishing, however, entirely to leave out the mineral history of a crop which, under other circumstances, would have demanded a large share of attention, we have made the following analyses. For the specimens we are indebted to Mr. W. Eggar, of Anstey, near Alton; they were common round white potatoes, grown on a gravelly soil:—

Specimen 1.—Collected August 21st, 1849, the plants being in bloom and the berries fully formed. Three plants were dried for analysis.

Specimen 2.—Collected August 29th, immediately after the bloom had dropped, from the same row as the previous specimen.

Specimen 3.—Tubers of the foregoing, collected in October, when the potatoes were fully matured, and the haulms had dried off.

Per centage of Water and Ash in Potatoes:—

	Water.		Ash.		Ash calculated on dry substance.	
	Tubers.	Haulm.	Tubers.	Haulm.	Tubers.	Haulm.
No. 1. The Bloom . .	80·72	88·40	·66	1·59	3·45	13·75
No. 2. After the fall of the Bloom . .	78·34	85·16	·60	2·25	2·76	15·00
No. 3. The Tubers being matured . .	72·94	..	·71	..	2·98	..

The two next tables give the composition of these ashes :—

Composition in 100 parts of the Ash of Potatoes :—

	Specimen No. 1.	Specimen No. 2.	Specimen No. 3.
Silica	5·46	1·18	·91
Phosphoric Acid . .	15·10	17·68	17·15
Sulphuric Acid . .	1·70	3·31	3·19
Carbonic Acid . . .	10·97	7·30	12·14
Lime	4·50	3·76	2·65
Magnesia	5·70	3·87	4·21
Peroxide of Iron . .	·29	2·11	1·06
Potash	50·88	50·93	50·89
Soda	none.	none.	2·41
Chloride of Potassium .	5·01	8·98	none.
Chloride of Sodium . .	·29	·88	5·38
Total	99·98	100·00	99·99

The *total* quantity of sulphur in 1000 grs. of potatoes undried was—

No. 1.	No. 2.	No. 3.
·035	·043	·063

Composition in 100 parts of the Ash of Potato Haulm :—

	No. 1.	No. 2.
Silica	2·20	8·22
Phosphoric Acid . .	6·62	2·27
Sulphuric Acid . .	4·58	5·12
Carbonic Acid . . .	11·46	14·09
Lime	29·86	37·02
Magnesia	5·46	6·00
Peroxide of Iron . .	3·89	3·78
Potash	10·07	11·44
Soda	none.	none.
Chloride of Potassium .	21·08	traces.
Chloride of Sodium .	4·77	12·06
Total	99·99	100·00

The *total* sulphur in 1000 grs. of the undried potato haulm was—

No. 1.	No. 2.
Not determined.	·029

The analyses now given of potatoes will serve to point out their general characters; they do not call for any particular remark in this place.

Grasses.

The examination of the natural grasses has always presented

considerable obstacles, owing to the difficulty of collecting proper specimens.

Two methods appeared open to us: either to have the various grasses cultivated in plots for the purpose of analysis; or to collect them from meadows in which they were growing. In the first of these plans much delay would necessarily occur, some of the grasses requiring several years to come to perfection, and the specimens being all grown in one set of circumstances, would scarcely be fit for comparison—the soil or aspect suited to one being exactly that which was least adapted to another. The second method—that of collecting the different grasses where they could be best obtained—seemed in many ways preferable, as it allowed of their selection from soils and localities in which they attained a healthy and flourishing condition.

It was decided, therefore, to collect the specimens as they grew in the pastures, an undertaking of great labour, and requiring the care of some one well acquainted with the characters and habits of the different grasses. We gladly offer our public thanks to Mr. Bravender, of Cirencester, who with the help of his son kindly undertook for us this most laborious work, for which his great practical knowledge of the subject so well fitted him.*

The specimens were collected whilst in full flower, except in cases where it is otherwise stated. They were carried from the fields in bundles and weighed as soon as possible, quantities of from 2 to 4 lbs. being preserved and transmitted to London by railway in tin cases. The whole quantities were then dried by a prolonged heat of from 130° to 150° Fahrenheit; any loss of water during their carriage would not therefore affect the results.

We are particular in specifying the manner in which the samples were preserved, in order that no mistake may occur. There seems to be no reason why a close approximation to the real per centage of water should not have been attained in this way; but whether this be so or not, the proportion of ash on the *dry grass* is not open to any question.

The following table gives the date of collection of some natural grasses and the nature of the soil from which they were taken. To avoid crowding the table the botanical names of the plants only have been mentioned; the local names are given in the next table following:—

* See Prize Essays by Mr. Bravender: Journal of the Society.

Nature of the Soil and date of Collection of different Natural Grasses:—

	Date of Collection, (Year 1849).	Nature of Soil, &c.
Alopecurus pratensis . .	June 1	Calcareous loam, gravelly subsoil.
Anthoxanthum odoratum.	May 25	Loam and calcareous rubble.
Avena pubescens . . .	July 11	Dry calcareous loam.
Bromus erectus . . .	June 23	Calcareous loam.
Bromus mollis . . .	May 8	Stiff loam.
Cynosurus cristatus . .	June 21	Calcareous loam.
Dactylis glomerata . .	June 13	Calcareous loam on gravelly subsoil.
Ditto, with seed ripe . .	July 19	Ditto ditto.
Festuca duriuscula . .	June 13	Dry calcareous loam.
Holcus lanatus . . .	June 29	Calcareous loam.
Hordeum pratense . .	July 11	Calcareous loam on gravel.
Lolium perenne . . .	June 8	Calcareous rubbly loam.
Annual rye grass . . .	June 8	Ditto ditto.
Poa annua	May 28	Loam with gravelly subsoil.
Poa pratensis	June 11	Dry calcareous loam.
Poa trivialis	June 18	Calcareous loam.
Phleum pratense . . .	July 11	Ditto.

It will be observed that, although these grasses were not obtained from one and the same soil, they are all from one district, and from land having a somewhat uniform character. The neighbourhood of Cirencester is in the oolitic formation, consequently the soils are all largely mixed with carbonate of lime; they are many of them of a "rubbly" (fragmentary) nature, and for the most part self-drained.

Per centage of Water, Ash, and Sulphur in various Natural Grasses:—

Botanical Name.	Common Name.	Water per Cent.	Ash on undried grass.	Ash on dry grass.	Sulphur per Cent. on the dry.
Alopecurus pratensis	Meadow Fox-tail Grass. .	80·20	1·55	7·81	·321
Anthoxanthum odoratum . . .	Sweet-scented Vernal Grass .	80·35	1·24	6·32	·183
Avena pubescens .	Downy Oat Grass . . .	61·50	2·01	5.22	. .
Bromus erectus .	Upright Brome Grass . .	59·57	2·11	5·21	·315
Bromus mollis . .	Soft Brome Grass . . .	76·62	1·36	5·82	. .
Cynosurus cristatus	Crested Dog's-tail Grass. .	62·73	2·38	6·38	. .
Dactylis glomerata .	Cock's-foot Grass . . .	70·00	1·59	5·31	·237
Ditto, with seed ripe	Ditto . . .	52·57	2·61	5·51	·248
Festuca duriuscula .	Hard Fescue Grass . . .	69·33	1·66	5·42	. .
Holcus lanatus . .	Meadow Soft Grass . . .	69·70	1·93	6·37	·278
Hordeum pratense .	Meadow Barley	58·85	2·33	5·67	. .
Lolium perenne .	Perennial Darnel or Rye-grass	71·43	2·15	7·54	·307
Poa annua . .	Annual Meadow Grass . .	79·14	·59	2·83	·218
Poa pratensis . .	Smooth-stalked Meadow Grass	67·14	1·65	5·94	·155
Poa trivialis . .	Rough-stalked Meadow Grass	73·60	2·20	8·33	. .
Phleum pratense .	Common Cat's-tail or Timothy Grass . .	57·21	2·26	5·29	·263
	Annual Rye-grass . . .	69·00	1·99	6·45	·165

In the proportion of water this table exhibits very considerable variation; such a result would naturally follow from the very different periods of the spring and summer in which the specimens were collected, and would no doubt be found in two grasses of distinct varieties collected from one spot and on the same day. It will be seen, however, that with very little exception the grasses which come early into flower contain the most water.

This circumstance, which is of importance in relation to the mineral composition of the grasses, will be best seen by grouping the specimens in the order of their collection, which is done in the following table:*—

	Date of Collection.	Water per Cent.	Ash per Cent. on wet substance.		Water per Cent.	Ash on wet substance.
Bromus mollis . .	May 8	76·62	1·36	Mean of the first four specimens	79·08	1·58
Anthoxanthum odoratum . . .	May 25	80·35	1·24			
Poa annua . . .	May 28	79·14	·59			
Alopecurus pratensis	June 1	80·20	1·55			
Lolium perenne .	June 8	71·43	2·15	Mean of the four specimens .	71·93	1·84
Annual rye-grass .	June 8	79·14	1·99			
Poa pratensis . .	June 11	67·14	1·65			
Dactylis glomerata	June 11	70·00	1·59			
Festuca duriuscula	June 13	69·33	1·66	Mean of the four specimens .	66·31	2·09
Poa trivialis . .	June 18	73·60	2·20			
Cynosurus cristatus	June 21	62·73	2·38			
Bromus erectus .	June 23	59·57	2·11			
Holcus lanatus .	June 29	69·70	1·93	Mean of the four specimens .	61·81	2·13
Avena pubescens .	July 11	61·50	2·01			
Hordeum pratense .	July 11	58·85	2·33			
Phleum pratense .	July 11	57·21	2·26			

Here it will be seen, that although the progression from very watery specimens in the month of May to much *drier* grasses in June and July is not altogether regular, yet it is well marked. Thus, whilst four specimens of grass collected between the first and last week of May afford on an average only 21 per cent. of *dry matter;* other four specimens collected during the two early weeks of July contain on an average 38 per cent. of dry matter, or nearly double. Practically it is known to be the case that the early grasses, valuable as they are for spring food, do not afford the same weight of hay as those which come into flower at a more advanced period: so that in calling attention to this circumstance we are merely enunciating in another form a well-known truth.

* The whole series of tables were constructed alphabetically before the advantage of an arrangement in the order of collection was perceived. Circumstances would not allow of their reconstruction.

Composition in 100 parts of the Ash of various Natural Grasses.

	Silica.	Phosphoric Acid.	Sulphuric Acid.	Carbonic Acid.	Lime.	Magnesia.	Peroxide of Iron.	Potash.	Soda.	Chloride of Potassium.	Chloride of Sodium.
Anthoxanthum odoratum . .	28·36	10·09	3·39	1·26	9·21	2·53	1·18	32·03	. .	7·03	4·90
Alopecurus pratensis . . .	38·75	6·25	2·16	·65	3·90	1·28	·47	37·03	. .	9·50	. .
Avena pubescens	36·28	10·82	3.37	. .	4·72	3·17	·72	31·21	. .	4·05	5·66
Bromus erectus	38·48	7·53	5·46	·55	10·38	4·99	·26	20·33	. .	10·63	1·38
Bromus mollis	33·34	9·62	4·91	9·07	6·64	2·60	·28	30·09	·33	. .	3·11
Cynosurus cristatus . . .	40·11	7·24	3·20	. .	10·16	2·43	·18	24·99	. .	11·60	. .
Dactylis glomerata . . .	26·65	8·60	3·52	2·09	5·82	2·22	·59	29·52	. .	17·86	3·09
Ditto, with seed ripe . . .	32·18	6·41	3·96	2·88	8·14	3·47	·23	33·06	. .	4·87	4·76
Festuca duriuscula . . .	28·53	12·07	3·45	1·38	10·31	2·83	·78	31·84	. .	8·17	·62
Holcus lanatus	28·31	8·02	4·41	1·82	8·31	3·41	·31	34·83	. .	3·91	6·66
Lolium perenne	27·13	8·73	5·20	·49	9·64	2·85	·21	24·67	. .	13·80	7·25
Annual-rye grass	41·79	10·07	3·45	. .	6·82	2·59	·28	28·99	·87	. .	5·11
Poa annua	16·03	9·11	10·18	3·29	11·69	2·44	1·57	41·86	. .	·47	3·35
Poa pratensis	32·93	10·02	4·26	·40	5·63	2·71	·28	31·17	. .	11·25	1·31
Poa trivialis	37·50	9·13	4·47	·29	8·80	3·22	·29	29·40	. .	6·90	. .
Phleum pratense	31·09	11·29	4·86	4·02	14·94	5·30	·27	24·25	. .	·70	3·24

The foregoing remark also applies to the per centage of ash, which, making allowances for differences in the nature of the plants, is found to *increase* with the advance of the season. Such should naturally be the case, since the ash is in great part a con

stituent of the dry matter, and would vary with the increase or decrease of the latter in the plant. The column in the table which represents the ash on the *dry* grasses does not exhibit the same variations as the one which precedes it, and for the reason just stated. The specimen Dactylis glomerata in its different stages of flowering and seeded is a good illustration of the point in question.

The preceding table contains the analysis of the natural grasses.

The points which, in examining this table, strike us as most worthy of remark are the following :—The universally high per centage of silica in all the grasses. This is a characteristic of the class ; it is accompanied with an equally high per centage of potash. It is remarkable that, whilst so large a quantity of potash is found in the ashes of these plants, there is scarcely a portion of soda *as such ;* there is, indeed, more or less of chloride of sodium (common salt), together with, in many cases, large quantities of chloride of potassium.* Another argument is hereby supplied in favour of the view which supposes the non-essential, or at all events secondary character, of soda in relation to vegetation.

The specimen of annual meadow-grass (Poa annua) differs from all the others with which it is associated in this table, both in the low per centage of silica and the corresponding increase in the proportion of potash. This grass is also peculiar in the proportion of ash, which, whether calculated on the natural or the dry specimen, is peculiarly low.† Reserving for the present any further observations that may suggest themselves, we pass on to the description of some other plants, which, although commonly called grasses, belong to other and different natural divisions.

To the per centage of water and ash in these plants the same remarks which we ventured to make in the previous case of the two grasses will apply, with slight modifications. Having large leaves and succulent stems, they however contain more water than the grasses collected at the same dates.

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* The chemical reader will understand that where the quantity of chlorine corresponds with the proportion of soda (sodium) in the ash, as it frequently does, it is considered to be combined with it; if it falls short, soda, *as such,* is said to be present; if, on the contrary, there is more than would form chloride of sodium, it is put down as chloride of potassium. When, therefore, the latter is mentioned in the analysis, it precludes the presence of *soda.* Although there are many circumstances in favour of this mode of stating results, it is never insisted upon as of absolute correctness, but as the only course open to the analyst.

† Annual meadow grass is said (see Low's Agriculture) to be the most productive of all the grasses. Is this in any degree to be attributed to its more moderate mineral requirements?

Nature of Soil and Date of Collection of different Clovers, 'Artificial' Grasses, &c.

	Date of Collection (1849).	
Trifolium pratense . . .	June 7	'Forest Marble' tenaceous loam.
Trifolium pratense perenne .	June 4	Calcareous loam, with gravelly subsoil.
Trifolium medium . . .	June 21	Ditto.
Alsike clover*	July 16	Calcareous soil of a nursery-ground.
Vicia sativa	June 13	'Forest Marble' loam.
Plantago lanceolata . . .	May 28	'Bradford Clay' calcareous loam.
Poterium sanguisorba . .	May 23	Ditto ditto.
Medicago sativa	June 16	Calcareous rubbly loam.

Per centage of Water, Ash, and Sulphur in various Artificial Grasses, Clovers, &c.

Botanical Name.	Common Name.	Water.	Ash on wet substance.	Ash on dry substance.	Sulphur per Cent. on the dry Grass.
Trifolium pratense .	Common Cultivated Red or Broad Clover	81·01	1·85	9·56	·269
Trifolium pratense perenne	Common Purple Trefoil, or Clover . .	81·05	1·58	8·35	·102
Trifolium medium .	Zigzag Clover, or Cow Grass	77·57	1·77	7·97	·206
Vicia sativa . . .	Common Vetch . .	82·90	1·11	6·50	·238
	Alsike Clover . . .	69·25	2·12	7·69	·251
Plantago lanceolata .	Ribwort Plantain-Rib Grass	84·75	1·32	8·68	·326
Poterium sanguisorba	Common Salad Burnet	85·56	1·15	7·97	·213
Achillea millefolium	Yarrow	..	..	13·45	·167
Medicago sativa † .	Purple Medick, or Lucerne	69·95	3·04	10·11	·273

The specimen of yarrow was sent to us by Mr. Henry Raynbird, of Hengrave, Suffolk; it was the growth of 1846.‡ For the rib-grass and burnet we have to thank Mr. Buckman, Professor of Botany at the Agricultural College of Cirencester, from whom they were transmitted through Mr. Bravender.

Here then we have a great change. With a quantity of potash equal to that found in the grasses, the specimens in the foregoing table are found to have little or no silica, but a high per centage of carbonate of lime. In most other respects the two classes of forage-plants have a mineral composition not greatly unlike. It cannot fail to strike the attentive reader that, whilst in natural

* This specimen was not collected till the seed was nearly ripe.

† Another specimen of lucerne, from the island of Foulness in Essex, gave upon combustion 10·70 per cent. of ash on the dried grass.

‡ The yarrow was dried in the air. In this state it contained 16·93 per cent. of water. We do not know what proportion of water it contained when fresh cut.

Composition in 100 parts of the Ash of various 'Artificial Grasses, Clovers, &c.

	Silica.	Phosphoric Acid.	Sulphuric Acid.	Carbonic Acid.	Lime.	Magnesia.	Peroxide of Iron.	Potash.	Soda.	Chloride of Potassium.	Chloride of Sodium.
Trifolium pratense* . . .	·59	6·71	1·85	23·47	22·62	4·08	·26	36·45	. .	2·39	1·53
Trifolium pratense perenne .	1·14	8·46	2·15	22·70	26·61	10·22	·33	22·12	2·82	. .	3·40
Trifolium medium . . .	·63	5·41	1·08	25·51	24·56	4·52	·23	34·72	. .	·85	2·46
Vicia sativa	1·28	10·59	2·52	18·73	20·78	5·31	·65	32·82	. .	3·27	4·03
Alsike clover	1·73	5·64	3·25	20·74	26.83	4·01	·71	29·72	. .	6·29	1·05
Plantago lanceolata . . .	2·37	7·08	6·11	14·40	19·01	3·51	·90	33·26	. .	4·53	8·80
Poterium sanguisorba . .	·83	7·81	4·84	21·72	24·82	4·21	·86	30·26	. .	3·27	1·35
Achillea millefolium . . .	9.9 2	7·13	2·44	9·36	13·40	3·01	·21	30·37	. .	20·49	3·63
Medicago sativa	59.	5·96	2·85	26·48	45·95	3·60	·75	9·99	. .	1·54	1·90

* For the analysis of other specimens of broad clover, see 'Journal of the Royal Agricultural Society,' Vol. IX., Part I., p. 5.

pastures grasses having a silicious ash greatly predominate, those plants which are recommended for cultivation, either alone or in mixture, and with the view of relieving as it were the productive powers of the soil, have an ash in which silica scarcely occurs.

The mixture of the different grasses in ever-varying proportions renders it difficult to give a statement of the mineral matter which is removed in the crop of an acre, but a fair notion of the generally exhausting character of a grass-crop will be obtained from analyses of meadow-hay which we are about to give.

The following is an analysis of meadow-hay, furnished to us by Mr. Paine, of Farnham. The meadows, which are of the most valuable description, are not actually water-meadow, but are at certain seasons overflowed by a small stream coming down through the chalk and greensand formation. To the passage of this water through the phosphoric beds of the upper greensand Mr. Paine is partly inclined to attribute the great productiveness of the land in question. We have no knowledge of the full per centage of water naturally in the specimen

Analysis of Meadow Hay.

Per centage of Water, Ash, and Sulphur.

Water.	Ash on Hay.	Ditto on absolutely dry Grass.	Sulphur on ditto.
14·20	6·64	7·73	·102

Composition in 100 parts of the Ash of Meadow Hay.

Silica	63·08
Phosphoric Acid	1·37
Sulphuric Acid	·65
Carbonic Acid	·16
Lime	12·89
Magnesia	3·42
Peroxide of Iron	·15
Potash	3·79
Soda	none.
Chloride of Potassium	6·05
Chloride of Sodium	5·40
	99·96

The large quantity of silica in the above ash was so unexpected that we were led to believe that an error had been made in the analysis; a repetition of the processes, however, gave the same result. It is evident that in the grass of this meadow some particular plant of a highly siliceous character must predominate.*

Amongst the series of grasses furnished by Mr. Bravender were specimens from a water-meadow at Stratton, near Cirencester. The soil is a rich loam with gravelly subsoil, and the crops produced by the aid of water are very large. Two square yards of an average part of the field were staked out and mown on the 30th of April. The produce in the green state weighed $11\frac{1}{4}$ lbs.

* See Analysis of Hordeum Pratense given at the end of this paper.

On the 26th of June the second crop from the plot of two square yards was cut; it weighed 8¼ lbs. The grasses composing the meadow were principally Poa trivialis, Holcus lanatus, Hordeum pratense, Avena pratensis, and Lolium perenne.

Per centage of Water, Ash, and Sulphur in Meadow Grass from Stratton.

	1st Crop, April 30.	2nd Crop, June 26.
Water	87·58	74·53
Ash on the undried grass .	1·28	2·24
Ditto on the dry grass .	10·37	8·82
Sulphur on the dry grass .	·197	·302

Composition in 100 parts of the Ash of Water-Meadow Grass.

	1st Crop, April 30.	2nd Crop, June 26.
Silica	9·24	34·11
Phosphoric Acid . .	9·31	5·56
Sulphuric Acid . .	3·55	4·23
Carbonic Acid . . .	11·62	1·15
Lime	9·50	9·13
Magnesia	2·47	2·49
Peroxide of Iron . .	1·31	·62
Potash	50·00	22·13
Soda	·09	none
Chloride of Potassium .	none	17·40
Chloride of Sodium .	2·91	3·14
	100·00	99·96

In the first crop of grass the quantity of silica is small, that of potash large, when compared with the natural grasses before analysed. The second crop has a mineral composition by no means unlike the average of these grasses.

From the data now given we may form a calculation of the quantity of mineral matter removed from the soil in two successive crops of meadow grass, where the produce is unusually large, as in the present instance.

The English acre contains 4840 square yards—it was seen above that the first crop from 2 square yards weighed in the green state 11¼ lbs.; the second crop from the same space 8¼ lbs.

Had the crop from an acre been weighed, the produce would, according to this estimate, in the fisrt case have been 27,225 lbs., or about 12 tons 3 cwt.; in the second 19,965 lbs., or 8 tons 18¼ cwt.

The first crop of grass gave, in the green state, 1·28 per cent.

of ash, or 348½ lbs. on the acre. The second gave 2·24 per cent. of ash, or 447 lbs. to the acre.

The composition of these mineral matters would be as under —in lbs. and tenths :—

	In the 1st Crop.	In the 2nd Crop.	In both.
	lbs.	lbs.	lbs.
Silica	32·2	152·5	184·7
Phosphoric Acid	32·4	24·9	57·3
Sulphuric Acid	12·4	18·9	31·3
Carbonic Acid	40·5	5·1	45·6
Lime	33·2	40·8	74·0
Magnesia	8·6	11·1	19·7
Peroxide of Iron	4·6	2·8	7·4
Potash	174·2	99·1	273·3
Soda	·3	—	·3
Chloride of Potassium . .	—	77·8	77·8
Chloride of Sodium . . .	10·1	14·0	24·1
	348·5	447·0	795·5

If the data upon which the preceding numbers depend are at all near the truth, the quantity of mineral matter removed by the two crops of meadow grass far exceeds anything that has come before us in the examination of other kinds of produce. The first crop is calculated to weigh when cut 12 tons 3 cwt. per acre—if made into hay, its weight would of course be greatly diminished. The quantity of water in well-made hay may be taken, for the sake of argument, at from 15 to 20 per cent. The 12 tons 3 cwt. of grass would, when *absolutely dry*, weigh 3375 lbs., or in the state of ordinary hay 3970 lbs., which is about 1 ton 15½ cwt.

The second crop in the same way would, by drying, from 8 tons 18¼ cwt. be reduced to about 2 tons 12½ cwt. (more correctly 5878 lbs.) of hay.

The whole produce of these two crops would therefore be, in the state of hay, 4 tons 8 cwt. of hay, a quantity which seems large, but is not impossible considering the extraordinary fertility produced by irrigation. It is worthy of remark in this place that the enormous quantity of mineral matter periodically removed from the soil, and amounting to more than 7 cwt., must in great part be furnished by the water, since the meadows in question are not otherwise manured.

In calculating the mineral composition of ordinary meadow-grass (not irrigated), we may with tolerable safety make use of the foregoing data, with the requisite reduction for the weight of the crop. Irrigation, whilst affecting the quantity of the grass, probably leaves its mineral composition relatively unaltered.

Since the foregoing was in the press, the analysis of two other grasses has been completed: the results are as follows:—

Avena flavescens (Yellow oat-grass). Soil—"Forest marble" loam. Collected June 29th.

Hordeum pratense (Meadow-barley). Soil—Calcareous loam on gravel. Collected July 11th.

	Water.		Ash.		Ash on Dry.
Avena flavescens	60·40	..	2·09	..	5·28
Hordeum pratense	58·85	..	2·54	..	6·18

The following is the composition of these grasses:—

	Avena flavescens.	Hordeum pratense.
Silica	35·20	56·23
Phosphoric Acid . . .	9·31	6·04
Sulphuric Acid . . .	4·00	4·29
Carbonic Acid . . .	..	..
Lime	7·98	5·04
Magnesia	3·07	2·42
Peroxide of Iron . . .	2·40	·66
Potash	36·06	20·26
Soda	·73	3·40
Chloride of Potassium .	..	..
Chloride of Sodium . .	1·25	1·66
	100·00	100·00

It thus appears that the ash of meadow-barley contains a far larger per centage of silica than any other of the grasses yet examined; and it may be that to its existence in large proportion in the meadow-grass from Farnham should be attributed the highly silicious character of that ash.

XXVII.—*Diseases of Cattle and Sheep occasioned by Mismanagement.* By W. Floyd Karkeek.

Prize Essay.

Amongst the various physical agents by which we are surrounded, and whose influences are particularly exerted upon our domesticated ruminants, food and temperature are the most powerful. From their birth these *animals* are greatly dependent upon the conditions in which they are placed for the future development of their frames, and it depends chiefly upon the care with which they are tended, and the knowledge by which that care is guided,

whether they shall grow up healthy profitable stock, or become unthrifty or weakly, and prove a loss to both breeders and feeders.

Both science and practice have established the fact, that a proper supply of food, and warmth, and air, is necessary for the rearing of healthy animals; but in each of these particulars the greatest carelessness or errors in management frequently prevail. The principal points laid down by this Society as the base of this essay have especial reference to two of these agents as extrinsic causes of disease amongst cattle and sheep; and a knowledge of their influences not only constitutes an essential branch of physiology, but is replete with practical pathological examples, of vital importance and universal application to the agriculturist.

In the order necessary to be followed, agreeably to the precept laid down by the Society, the effect of insufficient food is to be considered at different periods of growth—a very proper arrangement, as the several changes in organization, as well as in external circumstances, which cattle and sheep undergo, even in their comparatively short lives, may be expected to be attended with corresponding tendencies to disease. In compliance with this regulation, the *diseases of calves and lambs* will first come under consideration, afterwards *yearlings* and *hog sheep*, followed by *older cattle*, *milch cows*, and *breeding ewes*, &c.

1. Insufficient food at different periods of growth.—Most of the diseases of calves have reference to the organs of digestion and assimilation, and arise from derangement of the functions of the stomach and bowels.

Imperfect nourishment quickly embarrasses the digestive functions, producing loss of tone in these organs. Thus *constipation* is a very common complaint incidental to calves fed on skim milk. In these cases there is a quantity of hardened curd accumulated in the stomach—and there appears a want of power in the intestines of propelling their contents. This causes irritation, pain, swelling of the abdomen, inflammation, and generally death. Those who feed their calves in confined pens, or cold dirty out-houses, with little other nourishment than skim milk, are but too well acquainted with this highly dangerous disease; and they should understand that the vigour of the digestive functions cannot be maintained with such mismanagement; for although it may succeed with strong healthy calves, it induces disease in those whose constitutions are differently constituted.

This disease should not be confounded with another—that of the *rumen*—which is occasionally produced in calves that are taken from the cow immediately at birth, and taught to drink milk from the pail, which they very readily learn to do, and

sometimes swallow as much milk in a couple of minutes as would occupy a quarter of an hour in the operation of sucking.

It should be understood that the complicated digestive apparatus which is requisite for the ox is not called into action in the calf. The first and second stomachs are nearly closed, and the folds of the third adhere together, so as to form a narrow tube for the passage of milk direct into the fourth stomach. But this passage not admitting the milk as quickly as it is swallowed, it gets transmitted from time to time into the small but imperfectly formed rumen, which, becoming distended according to the amount collected, acts as an irritant, inflammation quickly follows, and death is the invariable consequence. In cases of this kind the rumen is found loaded with a mass of coagulated cheesy-like substance.

Aliment unfit in quality is also a very common cause of disease, producing *diarrhœa.*

From the preceding account of the peculiar organization of the digestive organs of calves, it must be evident that many articles of food, which in older animals become digested and nutritious, are likely to embarrass the stomach of the calf. Many of the substitutes used for milk, such as the meal of oats, wheat, barley, and linseed, sometimes act in this manner; when given at too early an age, or in too great a quantity at the commencement, proving indigestible, and more or less irritating, and causing increased action of the alimentary canal, with secretions augmented by the efforts made to get rid of the offensive matters. Calves are sometimes tempted to eat grass and other vegetable matters at a fortnight old, which is very certain to excite diarrhœa. Careful feeders seldom give them any other than liquid food during the first six weeks or two months.

These examples are sufficient to show the immediate ill effects of insufficient food in the rearing of calves; the future consequences will be alluded to hereafter.

The word "insufficient" is here considered in its broadest sense —food being insufficient when it is incapable of producing healthy nutritious chyle to the growing animal. The practice of rearing calves on skim milk, or cheese whey, is a very common but reprehensible one, and the feeder, if he does not suffer directly by incurring disease, is certain to lose indirectly in the quality of his stock. Milk contains casein, butter, sugar, and salts. The casein supplies the various muscular tissues, and the butter and sugar are used up in respiration, in preserving the animal temperature, and in the production of fat, which exists more or less abundantly in the bodies of young healthy animals, whilst the saline ingredients, containing the phosphates, supply the osseous structures. But by depriving the milk of its cream, the greater part of the muscle and fat forming principles are removed, whilst

the phosphates are rather in excess, and hence the origin of such a number of sharp-backed, flat-ribbed, coarse beasts that devour more food than stock of a better description, and when fattened present nothing but coarse beef, having scarcely a joint fit for the stall of a respectable butcher.

The object of good feeding is not to fatten young beasts, but to give strength and tone to the vital force, which, established in calf-hood, enables the animal to withstand many external agencies that tend to alter the form, structure and composition of the tissues, and predispose to disease. Breeders of calves will find it advantageous to accustom them to consume small quantities of linseed-cake when about six weeks old, and this increased in proportion as the milk is withdrawn. When the weaning takes place, the allowance of cake should be still further increased, which will prevent the check so commonly produced in their growth at this period, as shown by their large bellies and dry unthrifty appearance. The cake should be continued until the calves are so accustomed to the grass as to be able to dispense with it.

Many persons may imagine that this system of feeding may increase the liability to '*inflammatory fever*,' a disease known in some places as '*shewt of blood*,' '*quarter ill*,' '*felon*,' &c. &c., to which stock at this age, as well as yearlings, are exceedingly disposed. I have witnessed much of this fatal complaint; and my advice to the farmers, by way of a preventive, is to increase their strength and constitutions, which condition is not obtained by excess of food at any one time, but by regular feeding and proper management. The outset of the disease is a febrile condition, induced from sudden excess of food at a period when the tone of the vital principle is unequal to the work. The capillary arteries are more numerous and active in the early period of life than at any other, while they are carrying on and completing the organization of the frame. They are in fact the masons and architects of the system: but if a larger supply of building materials is forced into these vessels than can be efficiently used up in reparation and growth, active congestion takes place almost everywhere, the vital principle is suddenly reduced, the body becomes amenable to the ordinary chemical affinities, destruction of the living parts ensues by decomposition even whilst the animal is alive, shown by the extrication of gas in the cellular membrane and by the extensive sloughing process in the skin.

The great point then in the rearing of calves is to take care that the vital powers are predominant, which condition is only obtained by a proper supply of food, proper temperature, and proper exercise. The pathological view which I have taken repecting inflammatory fever appears to be consonant with experience. Why are not cattle in the course of fattening, or

milch cows, that consume enormous masses of food of a rich description, liable to this disease? Because the growth of these animals is completed, and the capillary arteries are reduced in number, and are neither active nor irritable as in younger animals; besides, other workmen are employed at this period of life—the one in the production of fat, and the other in the secretion of milk—both processes being safety-valves to the vital principle from excess of food.

2. Insufficient shelter and exposure to rain and cold, and the consequences resulting therefrom, will now come under consideration, when the subject of *insufficient food* will be further noticed.

The combined agencies of cold and wet on the animal frame are important and extensive. When continued for any length of time they appear to depress the vital functions, even to the extent of preventing the generation of heat. This effect is frequently seen in lambs on the Cheviot Hills during the lambing season, thousands of which die in this manner, besides ewes that have been insufficiently fed. To prevent the severe losses incidental to such seasons, shelter by mounds and sheds, and belts of plantations, are had recourse to with advantage.

But although shelter on those and other mountainous districts affords great security to the flock during severe inclement weather, there is another necessary object to be attended to, and that is the accumulation of a stock of winter forage, such as hay and turnips. The increase in the weight of wool and mutton, leaving the average mortality from the want of it out of the question, will amply repay the outlay. The sheep on the Welsh mountains also suffer considerably, and great losses are thereby sustained from want of shelter and exposure to cold. The low temperature on these truly Alpine regions may be imagined from the circumstance that sheep frequently wander to the height of 3200 feet on *Ben Nevis*, and the decrease of temperature with increase of elevation is in the ratio of 1° for 366 feet of ascent.

The management of cattle on mountainous districts is equally miserable. With the exception of breeding cows and calves, they are mostly wintered in the open field.* I have had no experience of the effect produced on cattle exposed to such influences; but Youatt † has given a distressing description of the winter treatment of cattle in the Highlands, the consequences of exposure to severe weather and starvation. A veterinary friend of

* "Excepting breeding cows and calves, all the cattle are wintered in the open fields. A little hay, and a few turnips, besides straw, is given in severe weather."

† "One-fifth of the cattle on the average used to perish from starvation in the winter, and the remainder are afterwards thinned by the diseases which poverty engenders."—*Youatt.*

mine, well acquainted with their present method of management, says, "The Highland farmers manage these things better now than formerly. Both hay and roots are provided, and rough shelter occasionally afforded in inclement weather. They have been taught by sad experience," he says, "the lesson which Liebig first promulgated in theory, that food in sufficient quantities is not only requisite to supply the waste and growth of the body, but for producing animal heat; and the more the cattle or sheep are exposed to cold, the greater is the quantity of food required to preserve their condition and health. Hence shelter is an equivalent for food."

But, confining our attention more particularly to the effect of cold and wet on the farmer's live stock in English agricultural districts.

First, with respect to sheep. These animals are able to bear both severe cold and wet, when they are sufficiently fed. It is this which preserves them under many a difficulty. Witness a flock of hogs folded on turnips midst snows and frosts and rain. Their natural dispositions are at war with such a system; but by the use of artificial food, such as linseed-cake or corn, they are rendered capable of withstanding these influences.

I have been accustomed to see much mismanagement of sheep with respect to insufficiency of food. I allude to the Leicester breed chiefly. They have great tendency to fatten, and quickly acquire flesh; but they are less able to bear exposure to cold in the absence of proper food than the South Downs. The Leicester sheep have greater development of lax extensible cellular tissue in the soft solids—their vascular and nervous systems are also more sluggish and inactive. These are points indicating temperaments of a lower degree of vital energy, and hence their constitutions are more easily acted on by these physical agents. In the absence of sufficient and proper food their wool becomes short, inelastic, and brittle, and the yolk is insufficiently secreted. In this weak and inefficient state the wool affords very little protection during wet and stormy weather; for, instead of throwing off the rain, which it will do when preserved in its integrity, it rather retains it, and this, acting as a chill, checks external secretion, constricts and obstructs the vessels of the surface, and the greater mass of blood is then thrown in undue proportions upon the internal organs, causing congestions of the mucous membranes of the alimentary canal and of the air-passages, inducing fluxes: here is the common cause of *diarrhœa* amongst lambs in the spring season when the ewes have been neglected in the winter, and rendered thereby incapable of supplying them with sufficient milk. Hence also we have *diarrhœa*, and *catarrh* with nasal flux amongst the hog-sheep in the winter and early spring.

On the first appearance of either of these fluxes, the shepherd should remove the flock to a sheltered situation, and keep them dry and warm. In every case they should have access to dry food, and there is no food equal to linseed-cake in these cases.

Acute dropsy in sheep—a disease known as "*red-water*" and "*water braxy*"—is found to occur frequently about the latter part of autumn or early winter, on low, damp situations, especially if there is a hoar-frost. I do not attribute this complaint to changes from dry to rich pasture, as some do, but chiefly to sudden chill produced from lying on damp, cold ground. Strange as it may appear, yet the surface of the ground is sometimes 6° and at others full 10° colder than the atmosphere only four feet above it.* The ice of dew and mist (hoar-frost) is formed when the temperature of the lower stratum of air which rests immediately on the soil sinks below the freezing point. The greater density of fogs and mists causes them to sink into the hollows of fields and in the valleys; and it is in these situations, on calm, clear nights, during the latter part of the year, that red-water is most commonly seen.

The pathological history of the disease is evident enough. The sudden partial cold acting on the belly of the sheep almost completely constricts the secreting vessels of the skin, and throws a corresponding amount of blood inwards, causing effusion of bloody serum into the abdominal cavity—hence the name *red-water*. This disease has its seat in the serous membranes of the abdomen. This form of dropsy is one of the sthenic or acute kind, and is attended with considerable fever, the invariable concomitant of acute inflammation in sheep. Its effects are so sudden, that hog-sheep apparently well in the evening are found dead in the morning. I have seen hundreds of these cases; and my advice to the farmers is, remove the flock to dry upland meadows, avoid all low wet grounds, and give dry food of some kind or other in every instance.

The effects of exposure to cold and wet are very evident on yearling cattle and two-year-old ones, kept in open straw-yards during the winter.

Calves are generally provided with shelter the first winter, but yearlings have to rough it very commonly amongst older cattle in open yards. Sheds may be seen here and there, and roots and straw are frequently found in abundance; but, gene-

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* Dr. Wells found the following temperatures during a clear sky on the surface of the ground, and in the air four feet above it:—

	h. m.	h.	h. m.	h. m.	h. m.
Time	6 45	7	7 20	7 40	8 45
On the ground	53°	51°	49½°	49°	42°
In the air 4 feet up . .	60½	60½	59	58	54

rally speaking, most of them are dirty, undrained, exposed places,* where the youngest and weakest are deprived of their proportions of roots and shelter, the older ones taking the greater share.

I have frequently observed that cattle can bear cold with indifference during dry weather, but they look out for shelter on the approach of rain. As far as our feelings are concerned, the sensation experienced in dry cold air is rather an increase of activity than otherwise; whilst humid air, at an equal temperature, produces a sensation of cold, that seems to penetrate the whole system, and particularly disposes the skin to paleness and shivering. If we may reason from analogy, cold and rain act in a similar manner on cattle, producing internal disease by deranging the circulation, particularly the capillaries, and causing congestions of internal organs.

Catarrh is oftentimes induced in this manner. This, in the strict sense of the term, commonly called *cold*, consists of inflammation of that portion of the mucous membrane of the air-passages which lines the nostrils, but, if neglected, is sometimes apt to extend beyond the nostrils, when it may produce bronchitis, which is a highly dangerous disease and requires prompt attention and all the aid that veterinary skill can afford. Cough creeps on insidiously in both cattle and sheep. When the disease reaches the bronchi the cough has a frequent painful husking sound, and is easily recognised by the anxious haggard look and rapid laborious breathing of the poor beast.

Catarrh is sometimes epizootic, that is, there is something in the air which oftentimes produces hoose of a dangerous character, beyond what is perceived by our senses. This is clearly shown by the very general or epizootic prevalence of the affection at certain seasons or certain character of winds or weather. Fever is almost invariably present in those cases, not always of the same character—sometimes active, at other times of a low typhoid kind: and of late years this constitution or type has more or less prevailed amongst horses.

Temperature in extremes, or sudden transitions from heat to cold, is a frequent cause of disease in young cattle.

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* The nature of the subsoil is of the greatest importance in determining the spot for erecting farm buildings, as dryness of the surrounding air is most permanently obtained in connexion with a soil from which the water of rain and dew speedily drains off, or evaporates, as on rocky surfaces; or sinks deeply, as in sand, chalk, and light gravel. Cold damp air constantly surrounding undrained straw-yards is proverbially unhealthy, and its disordering action may be in great measure traced to its physical properties of abstracting heat and electricity, and of checking perspiration and assimilation, which it obviously does. Dry air, on the contrary, at moderate temperatures, facilitates the purification of the blood in the lungs by improving the tone of the moving fibre, by checking tendencies to excessive secretion, and by counteracting various septic processes within and without the body, and it is one of the best safeguards against the activity of miasmatic poison, which is generally promoted by humidity.

In many parts of England it is a common practice to tie up cattle of different ages in the houses, during the winter, that are intended for depasturing in the following spring. Where there is plenty of room, good ventilation, and cleanliness, and the cattle not too suddenly exposed to the weather when turned to graze, there is not very much to object to the practice; but, generally speaking, the cattle buildings are quite inadequate for such a purpose; they are frequently in a wretched condition; there is seldom drainage for the liquid matters below, or free ventilation for the exit of foul aërial matters above, and the young cattle that are secured within them are far more liable to disease than those exposed to the inclemencies of winter's rains and snows.

Such a condition of things may do for fattening beasts, because in such a warm, close atmosphere, the respirations are but little exercised, and, the blood being but imperfectly decarbonised, fat will more readily accumulate. But a very different management is required in the rearing of stock intended for breeding or for depasturing in the summer. Under such a state of affairs the vital processes naturally become weakened, without, perhaps, disturbing any particular organ; and on the cattle being turned from their warm quarters into the open fields—oftentimes, too, with very little hair on their backs (for, from the hot-house system of management which they have undergone, they are prematurely preparing to put on their summer coats)—disease is induced in various ways. The sudden transition from heat to cold produces internal congestions—of the liver in particular, which has been stimulated throughout the winter with highly carbonised blood, and hence diarrhœa and dysentery are a common occurrence. Catarrh is also produced from the same influences, besides incurring a predisposition to any epizootic influence that may prevail.

My experience during a period of more than a quarter of a century as a veterinary surgeon, in an agricultural district in the west of England, enables me forcibly to contrast the methods of wintering store cattle, alluded to in this essay, with one now fast gaining ground in public opinion,—*that of keeping them in small yards, having comfortable roomy sheds attached, where they are sorted according to age, and supplied with a fair allowance of roots, hay, cake, or corn.* Supposing the summer's treatment to be the same, well-bred beasts managed in this manner are commonly tied up to fatten at about two years old, and manufactured into good beef at two and a half or three years old; whilst the same breed, ill fed in calfhood, and subsequently wintered in large open straw-yards, or in close ill-ventilated cattle-houses, and fed on turnips and straw chiefly, will generally take another year's keep, and are then only fit to be sold in store order. Thus, leaving the liability to disease out of the question, proper management, which implies

necessary warmth, food, and air, on which the body depends for healthy development, are desirable objects to be obtained in the rearing of cattle, even on the score of economy. I have not been advocating a forcing system, but simply recommending such food, from calfhood to the termination of growth, as shall insure health and strength and immunity from disease.

The period of the termination of growth—that is, of muscle or flesh—depends on the character of the breeds. The Short-horns, Herefords, and improved Devon cattle, and the improved long-wool sheep, such as Leicesters and Cotswolds, arrive at maturity a year sooner than those of most other varieties. From this period the nutrition of the muscular tissues ceases to a degree, and fat or milk is readily secreted.

We have seen that during the early periods of life the vital principles of both cattle and sheep are considerably taxed by resistance required to be made against cold, wet, and insufficient food; and predisposition to many diseases is formed from these debilitating influences in consequence. Thus *tubercles* are frequently formed in hog sheep and young cattle; but the majority being slaughtered for food before any constitutional disturbances take place, their effect is not often observed.

These abnormal deposits are the cause of consumption in cows. The organic materials of the body are more or less prone to decay, becoming effete or worn out in a limited period of time, and new ones are deposited in their places. But this renewal must depend on the supply of healthy chyle to the living structures; and if it be defective in quantity or quality, mal-nutrition takes place, and the fibrin of the blood, instead of acting as a plastic material for renewing the worn-out parts, becomes a source of tubercles, and the lungs speedily suffer, and that often to a considerable extent. They are also formed under certain pathological states, the consequence of exposure to cold and wet, such as congestions and chronic inflammations.

I find that hog sheep, bred and reared on sheltered farms, and fairly fed, seldom exhibit tubercles on the lungs on being slaughtered, whilst portions of the same flocks, reared on cold exposed places, are rarely slaughtered without them—studding the lungs as it were in every direction. On the hilly granite districts of Devon and Cornwall the farmers do not breed their sheep, but purchase ewes in lamb at the autumnal sheep fairs, of flockmasters residing on good sheltered arable land. The ewes and their progeny are sold fat the following year, and new stock purchased to replace them. These invariably exhibit tubercles, whilst the parent stock, as before stated, are free from the disease.

Chronic diarrhœa is another disease common to milch cows that have been improperly managed in early life. It is never

sudden in its attack, but generally the result of small yet reiterated application of causes, during which the ailment has been maturing unnoticed and unsuspected. This disease is more or less accompanied with loss of condition, and frequently occurs as a sequel to other complaints.

There is a hereditary taint in this disease, as well as the previous one, consumption; and hence breeders should beware of breeding from stock having such predispositions.

As a further illustration of those chronic diseases, consumption and diarrhœa, I would adduce the following examples:—During the winter and spring of 1846-47 the Farmers and Graziers' Cattle Insurance Association sustained considerable losses from cows insured by the Cheshire dairy farmers. The summer of 1846 was an exceedingly dry one, which occasioned a scarcity of winter forage; and the insurers, instead of purchasing hay, turned their cows into the open fields to graze whenever the weather permitted it. The consequence of this half-starved system of feeding, combined with sudden changes of temperature, caused an immense number of deaths. The cows are noticed in the books of the association as dying from the "*rot*," "*wasting*," "*shooting*," "*consumption*," "*went off*;" and numbers that escaped these complaints "*went off*" with the *pleuro-pneumonia*, which was rife in the district at the time.

3. Insufficient drainage of soil exercises an unfavourable influence on cattle and sheep, and the diseases induced in consequence are numerous and important. These are generally attributed to miasms, or deleterious principles developed in the land from the decay and exposure of vegetable substances to the sun. Under this head will be briefly considered various *verminous diseases*, *fevers*, *catarrhal epizootics*, and *epizootic infectious diseases*. These complaints are all rife in marsh or wet stagnant soils, and may therefore be considered under the same category.

Verminous diseases of sheep are the *rot*, produced from the fluke-worm (*Distoma hepaticum*), and the *sturdy* or *staggers*, caused by hydatids, the *Cœnurus cerebralis;* the former finds its seat in the livers and gall ducts, and is common to sheep in all kinds of condition that have been grazed in flooded meadows or undrained soils in the summer, whilst the latter more commonly attacks young sheep that have been neglected and ill fed. The predisposing cause of *sturdy* may be traced to insufficient nourishment, with a residence in a humid exposed situation.

Bronchitis (*verminous*) in calves and yearlings is also referable to the same debilitating influences. During certain moist warm

seasons, on undrained soils this disease prevails to such an alarming extent as to warrant the term *enzootic.* The windpipe and bronchi become filled with masses of worms (*Strongylus filaria*) and mucus, occasioning violent inflammation of the membranes of the air-passages.

The entozootic life led by these parasites after they are developed in the body is tolerably well understood, as well as the ravages they commit; but their origin *ab ovo* from the heat of the sun's rays on the stagnant soil, and their transmission afterwards through the blood-vessels, until they find their appointed places, are phenomena beyond my knowledge. That they are the product of spontaneous production, as some writers would inculcate, is very improbable; for, if so, new and dissimilar species might be formed every day by some unknown modification of the nutritive process which gives them birth. The most probable opinion is, that they are introduced from without, and perhaps undergo several changes before they appear in the internal form.

So far, the task to trace effects to causes in verminous diseases common to sheep and cattle on ill-drained lands appears not very difficult. There is something palpable to the mind, although invisible to the senses, in these miasms; but the *marsh miasmata*, the supposed agents of intermittent fevers amongst the rural inhabitants of fen districts, as well as fevers of various kinds amongst their cattle, which prevail more or less at certain seasons of the year, are more difficult to comprehend. The engineer Ranch says "that marshes are the ulcers of the earth, which blur the fair face of nature, where all should be beauty; and from these infectious sores the languor of death extends far and wide." Drainage and cultivation have done much in reducing the extent and insalubrity of the marshes of England; nevertheless they are still found in many districts, which defy amelioration by the utmost exertions of human foresight and labour. Those of Lincolnshire and Essex are examples. Kent, Cambridgeshire, Chester, Huntingdonshire, Lancashire, and Stafford, have also extensive marshes.

Fevers of a typhoid character are prevalent amongst cattle in the marsh districts of those counties; indeed, *catarrhs*, *fevers*, and *inflammations* assume a more depressing character on marsh lands than on the upland or hilly country adjoining.

Dysentery and *red-water* in cattle are diseases also common to swampy lands—whether produced from the insalubrity of the air, or from the stagnant water or coarse aquatic herbage with which these localities abound, is not exactly determined. Red-water is attributed by many veterinarians to the change of temperature of

the warm close days during the spring and autumn to the cold hoar frosty nights * so common in low marshy districts. It is very probable that two or more of these agents may act so as to produce the disease. These doubts do not apply to the causes of fevers in these localities, which are clearly traced to the effluvia from marsh miasmata.

In crowded, ill-ventilated cattle-houses, miasms of a similar character, for aught we know, are constantly evolved. The chemist cannot discover the nature of any of these aërial poisons, but their effects are visible enough; and it becomes a serious question to consider whether many diseases thus induced, at first enzootic and confined to certain localities, do not become, under certain conditions of atmosphere, not only epizootic but infectious.

The murrain of 1747, of which it is stated on authority that 30,000 cattle died in Cheshire in the course of half a year (the marsh districts of Lancashire, Lincolnshire, Nottinghamshire, and Leicestershire also suffered to a most alarming extent), is supposed to have originated amidst the marshy lands of Flanders and Holland. But of the origin of this murrain nothing certain is known. The same difficulty is experienced in tracing the origin of pleuro-pneumonia, an epizootic pestilence that has prevailed in this country since 1842. But thus much is certain of the latter disease, that it had been raging in Ireland for some twelve months before this period; that it was brought to the English side of the Channel by some half-starved Irish cattle, and in a very short time found its way into Cheshire, Shropshire, Staffordshire, and Middlesex; that its ravages have been more extensive in marshy districts, and in ill-ventilated crowded cow-houses, than in any other. So that whether these epizootics did really originate amidst swamps and malarious localities or elsewhere, there is not a question that they become increased, aggravated, and localized from miasmatic influences.

The Cheshire farmers relate some extremely curious instances respecting the pleuro-pneumonia; that of its visiting one farm, missing the next, suddenly appearing in the second and fourth,

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* In low valleys, during the months of May and October, after a hoar frost, *red-water* is frequently seen. The difference in temperature between the warm day and the freezing point, hoar frost being the ice of air, is sometimes as much as 20°, 25°, and occasionally 30°.

It should be understood that cold is not a fixed temperature, or range of temperature, but something considerably below the temperature of the body. Thus after the body has been warmed throughout the day at a temperature of 60°, it would very likely suffer from lying on the frozen ground at 32°. I am inclined to believe that dysentery, so common a disease in low marshy grounds in the autumn months, is frequently produced from disease of the liver and abdominal viscera induced by cold, causing congestion of those parts, and from the previous summer heat these organs are very likely to suffer in this manner. Many of the autumnal diseases arise from the great variations of temperature between day and night, and from sudden changes of wind, and these take more effect when they find the body relaxed by previous heat.

and so on, dotted about in this singular manner. Sometimes, after having carried off several cattle from a farm, it would absent itself for a few weeks, and then suddenly return without any assignable reason. Such temporary absence cannot be accounted for in many instances, otherwise than by supposing the germs of the disease to have during that time been brooding; and this by the by seems to favour the opinion now gaining ground amongst medical practitioners, that malignant epidemics are the result of the operation of living parasites—vegetable or animal—disturbing in sundry ways the functions and structures of the body, each after its own kind. The parasitic theory receives some support from the well-known fact that the pleuro-pneumonia was increased in virulence in crowded, dirty, dairy establishments of the metropolis and other large towns. Nothing tends to promote the spread of infectious disease more than the crowding together several animals who are suffering under it. Each one is a separate source of contagion, and, if these sources are multiplied in a cow-house, the air will be contaminated in proportion. *Warmth, closeness, and filth increase the virulence of contagion, of whatever kind it may be, and become as it were a nursery of pestilence.*

The first operation of malaria and aërial poisons is evidently on the blood, affecting both its quality and distribution, which becomes frequently darker in colour and otherwise altered, and accumulates to an extraordinary amount in some particular organ or structure. Hence the lungs and its membranes are the seat of pleuro-pneumonia, and here we have congestion with dropsical effusion of lymph and serum into the interlobular structure of the lungs and the cavity of the chest. In the "*variola ovina*," or "*sheep-pox*," the poison spreads its destructive ravages on the skin: the internal affections in this dreadful disease are simply inflammatory, and do not partake of the specific character of the cutaneous disease. The last disease may be promulgated either by inoculation or diffusion through the air.

4. Inattention to contagious diseases has occasioned much mischief and loss of property; for there cannot be a question, if but proper precautions were taken on the first appearance of a visitation of this kind in a neighbourhood, that its ravages might be considerably mitigated, if not altogether prevented in many instances.

When a disease of an infectious character threatens a farmer, he should immediately establish a rigid quarantine, and admit no new animals into stock until several weeks have established their freedom from any unhealthy symptoms. The wide spread of pleuro-pneumonia was occasioned by parties sending their beasts

to markets and fairs on the very first outbreak on their premises; and it is obvious from its peculiar incubating character—the first symptoms not making their appearance until seven, and in some cases fourteen days after the period of infection—that it could be conveyed long distances during the formative stage.

On the outbreak of an infectious disease on a farm, the very first thing to be attended to is the removal of the infected beasts to some suitable place far from the other cattle, where they can be watched and medical aid provided without endangering the remainder, which also should be carefully and daily inspected. I cannot conclude this part of the essay without urging upon farmers the strong necessity of judicious feeding, proper drainage, ventilation, and cleanliness generally, as means of rendering their cattle impregnable to some extent against infectious diseases. A striking proof of this is exhibited in the well-known fact that the high-bred cattle generally of England have been comparatively exempt from pleuro-pneumonia; the reason of which is sufficiently obvious—because more attention has been paid to their health and general comfort in every way.

With respect to the sheep-pox, it should be understood that this is a disease of such a virulent character, that it has been communicated through the medium of the atmosphere at a distance of 200 and 300 yards.* Thus it is not only communicated by contact, but by diffusion through the air.

A daily examination of the whole flock, with careful separation of the infected ones, is essentially necessary as a precautionary means of preventing the spread of this disease; and when it is considered that the infection may have been introduced into the flock by means of a single sheep, it shows the necessity as well as policy of the practice.

Inoculation of the sound sheep is also indispensable† as a means of preventing its destructive ravages. Professor Simonds, of the Royal Veterinary College, one of the best English authorities,‡ recommends inoculation as the safest and surest plan of lessening the mortality—the deaths from natural causes averaging 50 per cent., whilst in the very worst cases of inoculation the deaths do not amount to more than 6 or 8 per cent.

5. Carelessness on the part of shepherds and feeders occasions many diseases incidental to sheep and cattle. First,

* Delaford.

† The operation, however, is more difficult than with cow-pox; and, of course, a great amount of contagion must already exist around the farmer before he would have recourse to so extreme a remedy.—Ph. P.

‡ A very interesting and scientific treatise on the Sheep-pox has been published by Professor Simonds, which should be in the possession of every person having anything whatever to do with the diseases of sheep.

with respect to the cattle.—It is not enough that feeders attend to the conditions laid down in this essay for their general healthy management, by paying attention to their feeding, sheltering, and general cleanliness of the yards and buildings, only when sickness visits the farm—the very performance of which at such a time clearly shows their knowledge that such conditions are essential. Yet such is sometimes their inconsistency and carelessness in this respect, that their stock are no sooner restored to health than the same indifference to the laws of health is observed, as if they were altogether without influence.

The effect of extremes of temperature has been clearly exhibited in this essay, showing the importance of more attention being paid to the winter management of young beasts. The open straw-yards might be easily improved by being reduced in size, and the providing more efficient shelter by erecting of sheds, spouting the adjoining buildings, and constructing of drains.

Much of the mismanagement noticed in the cattle-houses might also be easily and cheaply prevented by constructing drains and ventilating holes. The baneful effects of polluted air on the animal frame have been, I hope, clearly exhibited. The carelessness of feeders or farmers in this respect is extraordinary. They should understand that a beast requires a draught of fresh air about 800 times an hour—which is conveyed directly to the blood through the medium of the lungs, and, by means of the circulation, is transmitted to every part of the body. But the value of this provision is materially lessened when, instead of pure fresh air, the noxious gases and exhalations of the cow-house are mixed with it. The deleterious influence of such agents is certainly short of a directly poisonous effect, yet it slowly and gradually undermines the health, and is only to be counteracted by more efficient drainage. Two things are necessary to be remembered in all attempts of this kind—first, the supplying the interior with fresh air; and secondly, the extracting the foul; and be it clearly understood, that the latter cannot by any means be removed, however well arranged its exit may be, unless an ample supply of fresh air is admitted into it from without. *It is the force of the air entering that causes the heated air to be dispelled.* This may be easily accomplished by providing outlets near the ceilings for the egress of the one, and apertures at the bottom of the house for the ingress of the other.

A few words also to shepherds. Constitutional vigour in sheep is regarded by them as a matter of paramount importance. Without this, light fleeces, deformity, and disease are constant attendants. But this valuable quality can only be maintained by judicious feeding at all seasons. A plentiful allowance of food for the ewes previous to the ramming season insures an extra number

of lambs; and the yeaning season is one that requires every care and indulgence on their part.

In many parts of the United Kingdom sheep are extensively employed in maintaining the fertility of extensive breadths of light soil, by directly consuming on the ground the common grasses as well as the ordinary green crops in conjunction with corn and linseed-cake. But it should be clearly understood that this is altogether an artificial state. The natural dispositions of sheep are at war with such a practice, for their very nature is a love of liberty; and although we have subjected them to this very profitable occupation, it should be clearly understood that they are more liable to disease in consequence, which can best be prevented by the assistance of artificial food, and every attention being paid to their general comfort. I have my peculiar ideas perhaps on the subject; but I cannot help thinking that a flock of sheep folded on turnips during rains and thaws, where the turnips are spoiled with mud and dung and urine, and where the sheep are compelled to lie on the wet poachy land,* is as miserable a sight as can well be conceived.†

6. Inattention to first symptoms of disorders, on the part of feeders and shepherds, occasions serious losses to their employers. Veterinary surgeons well know that the majority of fatal cases which occur in their practice proceed from not attending to the premonitory signs of disease. These are in cattle, loathing of food—" rumination suspended, or lazily performed "—the muzzle dry instead of being bedewed—respiration increased—hair pitched, and not licked: in sheep, carelessness of food—lagging behind the flock—averseness to move—depression of spirits—dropping ears and panting flanks on the slightest movement. When these symptoms or any of them make their appearance, the herdsman or shepherd may rest assured that disease is approaching, and it becomes his duty to act, and that without delay, as by doing so the disease may be mitigated or arrested—thus evincing the force of the old maxim, "venienti occurrite morbo." The knowing how to manage when these symptoms make

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* It is, however, a curious fact, for which I cannot account, that sheep often thrive better when folded on poaching land of good quality, than they will upon a dry sandy loam.—Ph. Pusey.

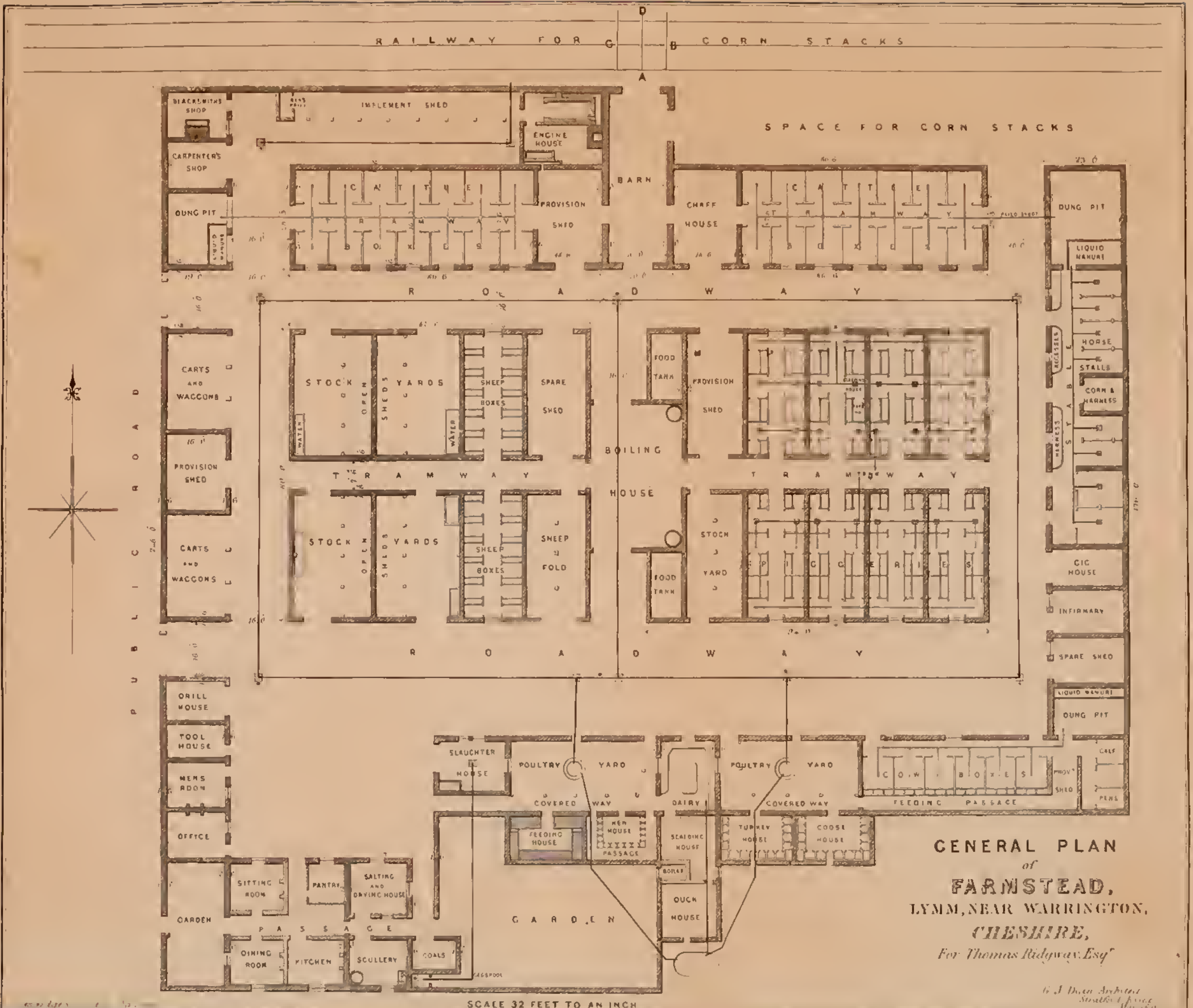
† In order to afford protection during winter weather, moveable folds have been constructed, having a light cloth covering, in which the sheep are confined during night, and where they can retire, if necessary, by day. Such protection as this will afford is of great service, but the plan hitherto has not met with many followers. It would afford much comfort and benefit to all grazing stock if shelter from the scorching sun of summer and the rains and storms of winter could be provided in every field. Hovels for this purpose might be furnished at very little expense, and in most fields corners may be found which the plough cannot touch, where they might be conveniently placed.

their appearance is an invaluable qualification. But this knowledge does not consist in the indiscriminate administration of physic and bleeding, which is dangerous to the stock and unprofitable to their employers. The groom attentively observes the slightest change in the condition of the horses under his care. If one of them coughs and shows symptoms of catarrh, he alters the temperature of the stable—changes the character of the food—and administers some simple stable remedy, or consults the usual veterinary medical practitioner. This is the knowing how to manage when symptoms of illness exhibit themselves, although of what precise nature sometimes the practitioner himself cannot at this early period exactly determine. With cattle, the management on the first appearance of disease is entirely different. The whole herd have sometimes the hoose; after a time one or more may exhibit symptoms more severe than the others, and the utmost that is done in these cases is very frequently little more than a drench, with shelter if it occurs in the winter months; and with this the efforts to remedy the disease seem to stop. Is it any wonder then, that the diseases of cattle, of the simplest kind at the commencement, become, from such neglect, dangerous and difficult to manage when the veterinary surgeon's assistance is required? Such carelessness has the appearance of cruelty, and the consequences at all events are the same. Very little attention to the causes of disease, as set forth in this essay, must show that they are more commonly the result of mismanagement than of accident or of circumstances which cannot be controlled, and even the agencies inducing epizootic and contagious diseases may be guarded against, or considerably modified, by proper and regular feeding—good drainage—and suitable yards, sheds, and farm buildings.

XXVIII.—*On the Cost of Agricultural Buildings.* By George Dean.

To Mr. Pusey.

Dear Sir,—Some time since you mentioned to me that I should be doing landed proprietors a service if I could point out to them the way in which they might be enabled to ascertain whether the sums charged by tradesmen for erecting agricultural buildings, or repairing them, be proper ones—if the materials used be suitable for the purposes to which they are applied—and the work properly performed. Knowing you take much interest in all matters connected with agriculture, and being a landed proprietor, I am desirous to afford you the information you seek. You are aware that to give non-professional gentlemen this information is no



GENERAL PLAN
of
FARMSTEAD,
LYMM, NEAR WARRINGTON,
CHESHIRE,
For Thomas Ridgway, Esq^r

easy task: I will, however, endeavour to assist them in acquiring it.

Previously to my so doing, allow me to describe to you a farmstead which has just been erected under my superintendence at Lymm, Cheshire, for Thomas Ridgway, Esq., a plan of which I forward you herewith. One consideration in erecting these buildings was, that they should serve as a model for buildings of a similar character. Should you think the insertion of the plan in the Journal of the Royal Agricultural Society desirable, it is at your service.

Publicity is not courted by the proprietor, but I am sure he will be pleased to allow gentlemen to see the buildings, should they feel disposed to do so. The plan sent is the original contract plan; and as the details of the several buildings is pretty fully explained by it, I will only describe their general arrangement. There have been a few alterations made in carrying the plan into execution, which are not shown, as they are of minor importance.

On referring to the plan, you will perceive the barn is placed centrally in the northern range of buildings, with provision and cattle sheds on each side. The barn is very small in comparison with those generally erected for such a sized steading, although sufficiently large for its intended purpose. A considerable saving is therefore effected in this one item.

Steam-power is used for threshing, and for various other purposes which will be enumerated.

The barn, provision-shed, and chaff-house, are each two stories high. On the upper floor of the barn is the feeding-place for the threshing-machine, and over the chaff-house and provision-shed is the granary. The dressing-machine is placed on the lower floor of the barn. The straw is also discharged from the machine on this floor, and raised by means of elevators to the floor above, whence it is conveyed through a gangway in the granary to lofts over the tramways of the cattle-sheds, which lofts are the width of the tramway, viz. 7 feet 6 inches.

Lofts over cattle-sheds, generally speaking, are objectionable; but here the sheds are, in consequence of the arrangement adopted, 29 feet wide, being more than double the usual width: therefore the objection does not apply, but, on the contrary, they are desirable, as, from their position, a more equal temperature can be preserved in the sheds, as care has been taken to well ventilate the cattle-boxes. The lofts are, from their great length, capable of holding a large quantity of straw, which can be thrown through trap-doors on each side of the lofts into the cattle-boxes, thereby economising labour. The additional cost of erecting the lofts is trifling, in comparison to their usefulness.

The corn, when dressed, is drawn up from the lower to the upper floor of the barn by machinery, and deposited in a spacious granary adjoining. On this upper floor is fixed the machinery for grinding beans, bruising oats, cutting chaff, &c.; and these, when required as food for the cattle, are lowered through a trap-door into a truck. This, when filled, is run along the tramway in the cattle-sheds, enabling one person to feed 70 or 80 beasts in a very short space of time. The truck has wooden shoots or troughs 2 feet 6 inches long on each side of it, which are hung with hinges, and have slides placed across the shoots which reach to the feeding-mangers on each side the tramway: therefore, by lifting up the slides, the prepared food passes down the shoots to the mangers, which are filled instantaneously.

Corn-sheds on posts (mere skeleton sheds) are erected behind the barn, and in these sheds rails are laid down. The corn is stacked on frames in the usual manner, but all the frames are wedged or blocked up, except one.—This is on wheels, and placed at the back of the barn, immediately adjoining the feeding-place of the threshing-machine, and is also loaded with grain. The grain stacked on this frame is the first to be threshed; and as the feeding-board of the threshing-machine is opposite and immediately adjoining the frame (as shown at A on plan), it is at once thrown from the stack into the machine with very little labour, a boy being enabled to perform the task easily. When the corn on this frame has been threshed, and another stack is required, the frame is run under the next stack (placed either at B, C, or D: see plan), it being 1 inch less in height than those which are blocked up. The blocks being knocked away, the frame, and the corn on it, rests on that on wheels. A rope is attached to the steam-engine machinery, also to the frame, and the stack, with its frame, is drawn to the feeding-place of the machine at the back of the barn. By repeating this operation, all the grain stacked may be conveyed to the machine without having occasion to thatch any of the stacks. Bean-stacks may be placed in the shed at B, oats at C, and wheat at D; or they may be placed alternately, thereby enabling the workmen to get at any particular stack after the first has been threshed, thus obviating the necessity for turn-tables, which are very costly. It is calculated that a saving of 10 per cent. will be effected by the erection of these sheds, and by adopting this means of locomotion, instead of building the stacks in the stack-yard, as is usually done, and afterwards thatching them,—then carting them from the stack-yard to the bay of the barn, and thence to the threshing-machine, independently of the security which the sheds afford from storms or rain during harvest (which in Cheshire is a very hazardous one). The facility given for carting a large quantity of

corn at one time; the security from wet weather in getting the corn from the stacks to the threshing-machine or barn; the security from the ravages of vermin; and the prevention of waste occasioned by throwing corn from off the stacks on to carts or waggons, prior to conveying it to the barn, are important considerations.

In the *stable* all the horses stand in stalls, and behind the stalls are recesses for containing the harness in daily use. By the use of these recesses, which are enclosed, the harness is preserved from the injurious effects of ammonia; and by being directly behind the horses, the carters will not in all probability be too idle to hang the harness in them; but if they were placed a short distance from the stalls, the harness would most likely be thrown down anywhere.

The strong black lines in the stables indicate the drains, which have gratings over them, and stench-traps attached to prevent the escape of noxious gases. The urine from the horses is conveyed by these drains to the liquid-manure tank.

The *piggery* is on rather an extensive scale, it being intended to fatten from 100 to 200 pigs at one time. The food is conveyed from the boiling-house along a tramway in a truck, whence the solid food is carried by hand up the passages on each side of the tramway to the feeding-troughs; the liquid portion is conveyed along the tramway in a similar manner, but conveyed to the feeding-troughs by a hose attached to the liquid-food truck, thereby giving greater facility for and economy in feeding. The strong black lines show the system of drainage adopted in these buildings. The drains lead to tanks, which are indicated by dotted lines on the plan, and marked thus: *

The *sheep* while fattening are kept in boxes on sparred floors, and beneath the floors powdered gypsum, charcoal, burnt clay, or some such substance, is placed for the purpose of securing the urine, fixing the ammonia, and housing the solid manure.

The *calves* stand on boarded and perforated floors, in which divisions are formed; these are removable, so that they may be lifted up, and the animal excrement taken away. The urine is conveyed from the pens by a drain to the liquid-manure tank, adjoining the calf-house. The calves are sufficiently near to the cow-shed for facility in suckling, and far enough away to prevent uneasiness in the cows by their bleating. A boarded and perforated floor is here used, in preference to a sparred floor. When the latter is used, the sharpness of the calves' hoofs comes in contact with the edges of the spars of which the floor is formed, and cuts the straw in pieces, consequently a great portion of it is wasted.

The mode of warming the poultry-houses for inducing early

incubation, is by means of warm water conveyed in pipes, the water being heated by a boiler in the sealding-room adjoining the dairy. This boiler supplies warm water to the dairy in severe weather.

Both warm and cold water-pipes are carried round the dairy for cleansing purposes, also for raising or lowering the temperature. From a tank erected over the engine-house next the barn, a pipe is laid to the dairy; and the fall from the tank being eonsiderable, the water rises in the pipe and forms a fountain, the playing of which also assists in lowering the temperature of the building in hot weather.

The *Cattle-sheds* require no explanation beyond that given on the plan, except that the strong black lines here (and elsewhere) indicate sunken channels formed in stone, for conveying the urine that may not be absorbed by the litter in the cattle-boxes to the liquid-manure tanks. All the other farm buildings will be sufficiently explained by the plan.

The strong black lines in the *roadways,* as shown on the plan, indicate the drainage; the dotted lines, small tanks for the deposit of sediment. These tanks have removable gratings fixed over them, and assist in carrying rain water off the surface of the roads through the gratings into the drains so soon as it falls, by whieh means the roads are nearly always in a comparatively dry state.

The house commands a good view of the premises, has a private entrance from the publie road, and direct communieation with the steading. All persons coming in or going out of the steading during the day, may be seen from the windows. The offiee, by adjoining the house, affords facility for business purposes; and the room next this, whieh is for the workmen, affords them an opportunity of getting their meals comfortably, as it has a fire-plaee in it, and is fitted up with tables and benehes; and it also affords the farmer or steward an opportunity of knowing the time the men go to and return from their meals.

The multiplicity of operations a steam-power engine is capable of performing is here shown. It drives the threshing-machine; the machinery for cutting chaff, turnips, and other bulbous roots; also that for bruising oats, grinding all sorts of grain; turning a circular saw, working a planing-machine, raising and lowering grain and straw to and from the ground-floor to the floor over the barn—works that for drawing the eorn-staeks by rope traetion from the corn-sheds to the feeding-board of the threshing-machine, and pumps water from the well into a tank; it also raises the water for supplying the boiler. Water is conveyed from the tank to all the farm buildings when required, also to the house. In case of fire, the engine (an eight-horse power)

may be employed to extinguish it by attaching hose, as it will throw water over all the buildings, and this for two or three days without cessation, should the supply in the well not fail.

The machine threshes and perfectly dresses every description of grain, occupies but little space, and is not costly.

The buildings are substantially erected with stone quarried on the estate, and with foreign timber of excellent quality. They are all slated with Welsh slates, the slates covering the roofs of the cattle-sheds being laid in such a manner that the buildings are all well ventilated, and the heat generally occasioned by the use of slate for the covering of buildings avoided.

The cost of erecting the whole of the buildings, including the house, together with the fittings of the mangers, racks, and troughs, in the various sheds; also the fittings of the house, dairy, &c.; that of erecting the steam-engine, threshing-machine, and all other machinery; the apparatus for supplying warm and cold water to the several buildings; painting the house both internally and externally, also the exterior of the several buildings comprising the steading, is, exclusive of stone, which was found by the proprietor, but quarried and carted by and at the expense of the contractors, about 2900*l*.

In looking at this amount, it should be remembered that the fittings are extensive and the accommodation also. The application of steam-power and machinery is greater than has hitherto been adopted in farm buildings of a similar extent. The economy of feeding and housing live stock has been more cared for than is generally the case. The facility for housing corn is greater than I have ever heard of, and the saving in the item of thatching only, is a considerable one, independently of the advantages arising from the use of such sheds, as previously explained.

The *steading* is the manufactory of the farmer, and, like all other manufacturing premises, should be so arranged as to ensure facility in performing the various operations and for economising labour, which latter is a very formidable item in farming accounts. In addition to these desiderata, it is of primary importance that suitable aspects be given to the several sheds, and that the live stock be properly housed and taken care of, so that they constantly accumulate flesh. Where they are not so cared for, the profit arising from fatting them is considerably lessened, and sometimes losses are sustained, instead of profit being gained.

Having described the plan and character of the buildings erected at Lymm, I will now endeavour to assist you in ascertaining whether the sums charged by builders for erecting new or for repairing old buildings be proper ones or not. The

sums charged are not a criterion of the value of the work performed, but the value depends upon the quality of the material used, the mode of executing it, and the time and labour bestowed upon it.

The extraordinary difference in the tenders of builders for the erection of buildings where competition exists, must have surprised most persons, it often varying from 20 to 30 per cent., and in some instances much more; therefore, where such difference in price is seen, there can be but little faith in charges made where competition is not called for. To guard against improper charges it is policy to require the builder to prepare a Specification of the work required to be performed, and the quality of the materials to be used. By adopting this course, the probable sum to be expended, or something like it, will be ascertained before the work has been begun; but care should be taken to guard against "*extras*," which are also often formidable items. If a builder undertakes to perform certain works, the intention should be to *complete* them for the sum or sums agreed upon, and he should not in such cases bring in a bill for extras; if he does do so, it should not be paid him. When an objection is raised by an employer to the sums demanded for these extras, the answer of the builder generally is, that the extra items were not included in the specification, or the contract entered into, and could not be anticipated. This is generally not the case; but presuming upon the want of practical skill of his employer in building operations, he stipulates in the specification to dig a certain depth for foundations, which he is aware is not sufficient, or to perform the work in such a manner that the contract must be broken, and the extra expense paid. To avoid these extra items, the contract should require the works to be properly and efficiently performed,—if for a house, in a manner suitable for occupation,—if for a building of any other denomination, suitable for its intended purpose. By adopting this course extras may frequently be guarded against, but not always, as they sometimes arise from circumstances which could not be foreseen, or by an extension of the original design.

To ascertain if the charge for extra work be a proper one, is difficult, because the market value of building materials, as with other marketable commodities, fluctuates considerably; in fact, it is a value rarely known by non-professional gentlemen; the best plan therefore to adopt is to require the builder to give a schedule of prices for the various descriptions of materials likely to be required; which has this advantage to recommend it, viz., should a portion of the work contracted for be unnecessary, data will be given for ascertaining the deductions that should be made in the amount of the contract. Power to make alterations, either by

additions to or deductions from the contract, should form part of the contract; and as the builder cannot beforehand know whether additions will be made, or deductions required, the schedule of prices will in all probability be a fair one.

The next points to ascertain are, whether the work is properly performed, and the material used of the quality stipulated for; in ascertaining which, the following hints will be found useful.

The materials used in a building should form part of its structural strength, and should not merely increase the ponderousness of the general mass. This can only be guarded against by the skill of the designer, and is not the business of the workmen.

It is of first importance that the foundations be secure—they should bear with unflinching firmness the superstructure to be raised upon them,—the grand object being to secure the requisite stability with the least expenditure. When compelled to employ artificial means to enable the earth to sustain the superincumbent weight of the building firmly, concrete will be found an excellent material for the purpose. It should be composed of fresh burnt stone or grey chalk-lime, ground to powder without slaking, and gravel, broken stone, or small pebbles, with a small quantity of sand in a dry state, added; and afterwards, water sufficient in quantity to bring it to the consistency of mortar when ready for use. After turning the whole over with a shovel until it is well blended, it will be ready for use, and should be used immediately, for if it *sets* before it is used it is valueless.

Various opinions are prevalent as to the relative proportions of lime, sand, and gravel; but the best is considered to be when one of lime to six or seven of gravel or pebbles, including sand, is used; the sand should be in proportion to the gravel as two or three to one, none of the gravel being larger than a full-sized walnut. The concrete should be about 9 inches wider than the footings of the several walls, about 12 inches in thickness, and the upper surface laid perfectly level.

Bricks should be hard, sound, well shapen, thoroughly burnt, and of uniform size. A well burnt, hard, sound brick has a peculiar ring when two are knocked together; whereas soft, badly burnt bricks are of a spongy nature, unsuitable for buildings, soon fall to pieces from the action of the weather, or on knocking two of them against each other. In laying bricks stability and beauty are obtained by regularity. No four-course should exceed 12 inches in height; they should be well bonded together, that is, connected by being placed in juxta-position, every fourth brick being laid transversely to the wall. The mortar should be bedded evenly, and all the joints between the bricks well filled with it: it should be composed of one portion of lime to three of sand.

Stone for walls for agricultural buildings is only used in districts

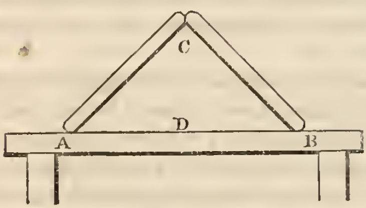
where the material abounds; the mode of construction is so well understood by the workmen in such districts, that it requires no comment here, except that the stone be well bonded, as described for brickwork, set on its natural bed, that is, in the position in which it is found in the quarry, and cramped with metal cramps where requisite.

Carpentry is a mechanical art, requiring considerable skill on the part of the carpenter; and in consequence of the art being scarcely understood by non-professional gentlemen, the builder is enabled to defraud his employer with impunity, should he be so inclined.

The scientific framing of roofs, floors, partitions, and all other descriptions of framing, affords the most satisfactory applications which can be made of mechanical science to the arts of common life; but it is a science rarely acquired by country artizans. This want of skill leads to an injudicious disposal of materials, oftentimes wastefully applied, and they are frequently incapable, from position when fixed, to resist the various strains to which they are subjected.

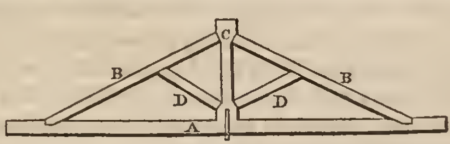
Roofs in particular should be so constructed that the tendency which they have, from their position, to overturn the walls they rest upon, be counteracted. This is most effectually guarded against when beams of timber or rods of iron extend across the building at the top of the walls, and secured to the wall-plates; they are then called "ties," and these ties should not be placed more than 10 feet apart. It is from the absence of them, and the low pitches or angles often given to roofs, that premature decay and destruction are occasioned to buildings thus constructed. The annexed diagram will illustrate this fact.

Let A B, B C, C A, be three timbers, of which the two last rest on the first, A B; it will at once be seen that B C, A C, by their weight alone, will slip at the points of bearing and fall; at these points, therefore, they must be secured, which may be done by form and by auxiliary means; by its own weight the beam A B would



bend, tending to fall inwards, and to overthrow the walls; but if B C and A C are firmly secured at A, B, C, and A B is tied up by C D, neither the first nor second evil can occur, and we have a truss; the mechanical action of tie-beams, principals, king-posts, queen-posts, princesses, struts, collar-beams, or straining pieces, is involved in this principle; as where the tie-beam is of great length it is upheld by a king-post, two queen-

posts, and two princesses, or wrought-iron bolts, bearing the name of bolt instead of post; the principals, from their own as well as the superincumbent weight, are liable also to deflection, which is opposed by struts and collar-beams. It is by a considerable application of these auxiliaries that scientific trusses are constructed with little weight and great economy of timber, which otherwise often could not be put together at all for want of beams of sufficient size. Under 30 feet span, a tie-beam A, and principals B B, with king-post C, and struts D D, are sufficient; under 20 feet span we may dispense with the struts; but we shall require an extra depth for the principals.



From 30 to 45 feet span, a truss should be composed of two queen-posts, and a straining piece between their heads, and struts from the queen-posts to the principals.

From 45 to 70 feet span a truss will require two queen-posts, and two small queen-posts (or princesses), with a straining-piece between the queen-posts and struts, from the queen-posts to the princesses; also struts from the princesses to the principals; above 60 feet span a straining-sill may be added on the tie-beam between the queen-posts.

The duty of the king-post is to suspend the tie-beam and prevent its deflection; the common practice, of morticing the king-post close into the tie-beam, is objectionable, as being by no means the most efficient way of counteracting the bending of the beam; for, on the contrary, from the general contraction of all the timbers, as well as by any settlement which will most likely occur in the principals, the king-post, as well as all timbers effecting a similar purpose, will press down into the tie-beams, and of course deflect them; it is a common practice to attempt a counteraction of this, by cambering or arching the tie-beam, but this is only in a measure submitting a truss to continual action, whilst perfect repose is what is required; and this repose will be best obtained by suspending the tie-beam from the king-post, &c., by the means of wrought-iron stirrups. After deflection, from settlement or otherwise, the tie-beam should be wedged or screwed up, when all the members will be restored to their intended actions.

The only duty of struts is to prevent the principals from bending under their own weight or that laid upon them, and they must therefore be directed to the points of deflection, which will also

be the position of purlins; and it must not be forgotten that struts, as well as all inclined timbers, increase in strength with the size of the angle of inclination, until at maximum, when the piece will be vertical, or the sine equal to the radius.

Struts should never on any account rest on the tie-beam, as they then tend very considerably, according to the weight of the roof, to deflect, and to strain the beam, which in its turn acts most injuriously upon the walls, which it tends to upset.

All the timber used in trusses should have been felled at least two years, and should have been at least six months out of water; builders, however, often employ timber soaked with water, and the result, after a few months, is considerable shrinkage, and consequently splitting from abutting joints; to this most injurious evil struts and principals from their position are peculiarly liable, the first at the heads, and the second at the feet; but preparations against the evil may be made by leaving the abutting joints open at the internal angle nearest the post.

The introduction of iron in trusses is comparatively an introduction of recent date, but within the last few years its use has rapidly increased. Wrought-iron for trusses should be of the best scrap quality, and free from all flaws; it should be carefully examined piece by piece before it is allowed to be used, and all faulty samples should be thrown aside. Spikes should be flat-edged, and they should be driven with the edge across the fibre of the wood, and not longitudinally with the timber, which would tend to split it.

With regard to bolts, when they are round, the holes made to receive them should be exactly of the same diameter as that of the bolts, and should be driven exactly parallel to the sides of the wood that are to be parallel to the bolt; for square bolts the hole should be somewhat less than the diagonal of the bolt.

Bolts and nuts should be well greased before they are used; when of great length they should be of sufficient diameter to resist torsion, and they should never be placed too near the end of a timber; care should be taken that screw-bolts and screws are not hammered, as the fibres of the wood are thereby torn; it is a gross error to fancy that the elasticity of the wood will prevent this laceration. Whenever it is feared that a nut may slacken by a retrograde motion, a second nut may be added, which will effectually prevent any loosening.

Iron straps and stirrups should, before use, be heated to a blue heat, and then saturated with raw linseed oil, as a preventive against rust. A strap one inch wide may be $\frac{3}{16}$ thick; $1\frac{1}{2}$ inch wide, $\frac{5}{16}$ thick; and 2 inches wide, $\frac{3}{8}$ thick. Straps should be secured by screws, the heads of which should be countersunk, and sometimes by bolts. Cast-iron plates and shoes are very

useful to receive and to equalize the thrust from the ends of butting timbers; the first particularly, where they are employed as a connecting surface between the butting ends of timbers, which from shrinkage, defect of workmanship, or otherwise, may come to bear upon opposite angles, instead of the whole area of their intended connecting surfaces. A most reprehensible practice is that of hammering and twisting straps and stirrups after they are cold; this should never be permitted, as it cannot be done without injuring wrought-iron.

The duties of king-posts, queen-posts, &c. being suspension, they may be efficiently, and with advantage, replaced by wrought-iron rods, as may be all timber ties; from $\frac{3}{4}$ of an inch to $1\frac{1}{2}$ inch diameter, will in almost any case be sufficient. They should pass through the timbers, and be secured by nuts outwardly, of three times the diameter of the bolt; when in connexion with struts, they may pass through the cast-iron shoe receiving the strut. By these means the tie-beam may be suspended from any number of points, and a truss of great span, with little weight, constructed.

The methods of joining timbers are various, and require particular attention from the constructor, as they should always be effected according to the position and strain on the connected timbers at the joints; tenon and mortice, joggle, notching, or cocking down, butting joints, scarfing and building, or modifications of these, are the principal combinations of timbers in trusses.

In tenon and mortice the tenon is cut on the end of one timber, and the mortice is cut in the face of another to receive the tenon. In the square tenon and mortice the thickness of the tenon is made one-third of that of the timber in which it is cut; the shoulders should be in exactly one plane, and perpendicular to the axis of the timber in which the tenon is cut. By these means, after shrinkage, an equal bearing will be obtained, which is most desirable in case of weight on the shoulders, one of which would otherwise have a tendency to split from the main timber. The cheeks of the tenon should also be perfectly parallel to the axis of the timber; the size, or sectional area of the mortice, should be exactly equal to that of the tenon, but the depth of the mortice should rather exceed that of the tenon, that the weight may bear on the shoulders, and not on the head of the tenon itself, the area of which is only one-half of that of the shoulders. The cheeks of the mortice must be quite parallel to the axis of the timber in which it is cut. When acting by suspension, but little depth is required, if secured by a strap. An oak trenail should be driven through mortice and tenon, the hole being pierced after

the joint is adjusted, and this hole must be quite square with the timbers; the diameter of a trenail should be one-third of the depth of the tenon from the shoulders. Trenails are not to be depended upon for the strength of joints, as this should result from combinations of one timber with another, and it is only for the setting up that their assistance should be required.

The following are the best known scantlings of timber with which to construct roofs, partitions, and framed floors:—

Scantlings for Roofs, Trusses not more than 10 feet apart, Pitch $\frac{1}{4}$ of the span, Yellow Fir Timber, and Slate Covering.

Span in feet.	Tie Beam in inches.	King-Post in inches.	Principals in inches.	Struts in inches.	Purlins in inches.	Com. Rafters in inches.
20	$9\frac{1}{2} \times 4$	4×4	4×4	$3\frac{1}{2} \times 3$	$8 \times 4\frac{1}{2}$	$3\frac{1}{2} \times 2$
22	$10 \times 4\frac{1}{4}$	$4\frac{1}{2} \times 4\frac{1}{2}$	$4\frac{1}{2} \times 4$	4×3	8×5	$3\frac{1}{2} \times 2\frac{1}{2}$
25	$10\frac{1}{2} \times 5$	5×5	5×4	$4\frac{1}{2} \times 3$	8×5	$4 \times 2\frac{1}{2}$
27	11×6	$5\frac{1}{2} \times 5\frac{1}{2}$	6×4	5×4	$8\frac{1}{2} \times 5$	$4\frac{1}{2} \times 3$
30	12×6	6×6	$6 \times 4\frac{1}{2}$	6×4	$8\frac{1}{2} \times 5$	$5 \times 3\frac{1}{2}$

Scantlings of Girders, 10 feet apart.

Length in feet.	Depth in inches.	Breadth in inches.	Length in feet.	Depth in inches.	Breadth in inches.
8	8	$5\frac{1}{2}$	8	9	$4\frac{1}{2}$
10	9	7	10	10	$5\frac{1}{2}$
12	10	8	12	11	$6\frac{1}{2}$
14	11	$9\frac{1}{2}$	14	12	$7\frac{3}{4}$
16	12	$10\frac{1}{4}$	16	13	$8\frac{1}{2}$
18	13	11	18	14	$9\frac{1}{2}$
20	14	$11\frac{3}{4}$	20	15	10
22	$14\frac{1}{2}$	$13\frac{1}{4}$	22	16	$10\frac{3}{4}$
24	15	$14\frac{3}{4}$	24	17	$11\frac{1}{2}$
26	16	$15\frac{1}{4}$	26	18	12

Scantlings of Binding Joists, not more than 6 feet apart.

Length in feet.	Depth in inches.	Breadth in inches.	Length in feet.	Depth in inches.	Breadth in inches.
6	6	4	16	11	$7\frac{3}{4}$
8	7	$4\frac{3}{4}$	18	12	$8\frac{1}{4}$
10	8	$5\frac{1}{2}$	20	13	9
12	9	$6\frac{1}{4}$	22	14	$9\frac{1}{2}$
14	10	7	24	15	10

SCANTINGS of Fir Joists for single Flooring.

Length in feet.	Width in inches.	Depth in inches.	Length in feet.	Width in inches.	Depth in inches.
6	2	6	14	2½	9
8	2½	7	16	2½	12
10	2½	7½	18	2½	12
12	2½	8	20	3	12

The next consideration will be to ascertain the qualities and properties of the several descriptions of timber most commonly used. That of oak is well known, and requires but a passing notice. Among the varieties is the *Esculus*, or holm oak, which is very useful for building purposes, but is soon destroyed by damp. The *Quercus alba*, or American oak, and the *Quercus rubra* of Canada, are of quick growth, but are not so durable as the British oak. The Riga oak is very clean, and free from knots, and is well suited for forming floors. Oak, when properly seasoned, loses nearly two-fifths of its original weight; hence the necessity for allowing sufficient time for the juices to be thoroughly drawn off.

Where posts or piles are to be driven into the earth, they should be charred, but if the process is performed upon unseasoned timber, it is highly injurious, as it confines rather than expels the juices, which by fermenting causes premature decay. It varies in its specific gravity, according to the soil which produces it; its strength is in proportion to its density, and that timber is the most durable which has this quality in the highest degree. Density is mainly owing to the length of time occupied in the production of the wood; that which grows fast, as it will do on light soils, is not so heavy, or so hard and compact, as that produced on cold soils, which is of slower growth.

Trees which are suffered to complete their growth have heart-wood throughout of the same weight and strength; while those cut down prematurely are found to possess these requisites only in their centre-wood, which is considerably harder than that formed by the outer concentric rings. It may be said to decrease in hardness in arithmetical proportion as it approaches the sap-wood.

Fir is preferable to oak for girders and general framing, in consequence of its lightness and inflexibility: it is also less liable to warp than any other timber, especially when in boards or small scantling; is less expensive to convert than oak; is not quite so durable, but much cheaper. The red or yellow fir (*Pinus sylvestris*) is the best and most durable of the whole varieties. The best quality has its annular rings much thinner than that of inferior timber, and in sawing does not cut so as to leave a woolly surface, neither is it spongy.

The fir timber imported from Norway seldom exceeds 18 inches in diameter, but it is durable, notwithstanding the large portion of sap-wood which it possesses. That from Russia is considered to lose much of its quality from the length of time occupied in getting it from the interior to Cronstadt, from which port it is shipped.

White fir (*Pinus abies*), commonly called Spruce, is inferior to the red or yellow; it is imported from Christiania, mostly as deals or planks. Where continually dry it is durable, is chiefly used in the interior of buildings, and takes glue better than the red or yellow. The *Pinus strobus*, which is grown in North America, is imported as logs, which are of great length and size. It is very susceptible of dryrot, and is not considered to be durable; it should never be used for girders, or in any situation where it is subject to much strain.

Pine is known as red and yellow. The yellow possesses greater strength and durability than the white. The annual rings, in the best sorts, seldom exceed one-tenth of an inch in thickness; the wood is hard and dry to the touch, does not leave a woolly surface after the saw, or clog its teeth with resin. The annual rings in the inferior kinds are generally thick, the wood heavy, and filled with a soft resinous matter, feels clammy, and chokes the saw while sawing it. Much of the timber imported from Sweden is of this inferior quality.

Pitch pine (*resinosa*) is a native of Canada; its wood is brittle when dry, heavy, and full of turpentine, and is not durable. It is distinguished from Scotch and other European pines by a deeper red;—from its glutinous property it is difficult to plane.

Larch is of rapid growth, and if grown on elevated situations very durable; possessing great strength, it is suitable for framing, and almost every description of carpenter's and joiner's work. It will not easily take fire, nor split by the driving of nails into it, neither will worms attack it; from its hardness it is well adapted for posts, rails, barn and cottage floors. It is to be regretted that the growth of this valuable timber-tree is not more encouraged in this country, as it will grow in almost any soil or situation.

Elm is another description of timber-tree, far superior to some of the foreign timber imported, and may be grown at a much less cost. Its value is not fully appreciated, although evidence of its usefulness and durability is given in old barns and other buildings, both for framing purposes as well as for weather-boarding. For piles its value is well known; that which was used in the foundations of Old London Bridge, upon its removal was found to be in excellent preservation.

The *Poplar* is another tree which may be used with propriety and economy for flooring: it does not split on being nailed down, nor does it readily take fire; and as neither mice, wood-lice, nor

1806.			lbs.
Nov. 22.	Put to barley-meal, live weight . . .		302
	1 bushel barley-meal.		
,, 29.	1 ,, ,,		
Dec. 6.	1 ,, ,,		
,, 13.	1 ,, ,,		
,, 16.	Weighed alive		364
,, 20.	1 bushel barley-meal.		
,, 27.	1 ,, ,,	weighed alive . .	380
1807.			
Jan. 10.	Weighed alive		408
,, 13.	1 bushel barley-meal.		
,, 20.	1 ,, ,,		
Total . .	8 ,, ,,		
Jan. 27.	The day killed, weighed alive . . .		443
,,	,, ,, ,,	dead	328

	lbs.		lbs.
The four quarters . .	299	Loose fat	11
Head	24	Pluck	16
Fat	5	Offal	88
	328		443

XXX.—*On Irrigation as practised in Switzerland.* From Henry T. J. Jenkinson.

To Mr. Pusey.

My dear Mr. Pusey,—As you wished me to collect what information I might be able to gather, during a summer trip in Switzerland, as to the system of irrigation pursued in that country, I have now the pleasure to send it you. Through the kindness of Mr. Morier, our late minister in Switzerland, I was provided with letters of introduction to M. Jean Gaspar Zellweger of the canton of Appenzell, who was good enough to give me letters to some practical agriculturists; and I may consequently hope that the information I have obtained may safely be relied on.

The system of irrigation appears to have been practised in Switzerland as early as the fourteenth century, and has doubtless been so extensively introduced owing to the dryness and rarity of the atmosphere; but on account of the variety of the position of the various cantons there are some modifications in the management of water-meadows.

In the Canton of Aargau, which contains some of the best land in Switzerland, the meadows are irrigated with water alone, where the nature of the ground admits of its application. My in-

formant, M. Jean Herzog of Aarau, told me that the water they apply possesses the most fertilizing qualities—that it is of a peculiarly soft nature—and that he has at times observed a kind of soapy or oily (*savoneuse*) substance floating over the meadows when they are in water. When the streams are increased by the melting of the winter snows, the water loses its efficacy, but when thickened with rain their efficacy is increased. Also when the water is suffered to flow over too large an extent of land its virtue is invariably diminished. M. Herzog also informed me that he never irrigated during the full moon, as he had always observed that when the meadows were allowed to remain in water during the clear moonlight nights that the grass was perceptibly weakened, and that its very colour was affected. He had applied water to different parts of the same meadow during the full and new moon, and had experimentally verified this fact.

During the *extreme* heat of the summer the water is not left on the meadows by day, but is turned on during the night.

The water is supposed to act as a species of *manure*. The tests of that description of water which may be applied with advantage to the purposes of irrigation are—

1. The power of dissolving soap.
2. The good quality of the trout that inhabit the stream.
3. The growth of the water-cress and weed at the bottom of the water.

Spring water from a source warm in winter and cool in summer is by some persons considered more productive than the water of streams.

Streams that leave calcareous deposits on their banks, or that form petrifactions, are always injurious, and those inhabited by coarse fish alone are generally bad.

M. Herzog's method of treatment of his water-meadows is as follows:—After the last crop of grass is cut, which generally takes place in the beginning of October, the water-courses are cleared out, the hollows are thus filled up, and the meadows are irrigated during the months of October, November, and December, till the hard frosts commenee and the winter snows fall. Should there be snow and the weather not very severe, the water is still kept flowing over the meadows in order to melt the snow; but as soon as there is any fear of the water freezing irrigation is discontinued.

The water is made to flow over the land for two or three days. It is then turned off and employed in irrigation elsewhere; and after the interval of a week or a fortnight, according to the appearance of the grass, it is again made to flow over the same land for a similar period. This system is continued till the irrigation is stopped by the frost and snow, and the irrigation during the

months of October, November, and December is considered as the most beneficial to the land. During the spring, when the streams are swollen with the melting of the snows, irrigation is discontinued. In March the system is recommenced, but the land is left dry for longer intervals. In April the first crop of grass is cut. This crop of *grass* is made use of for the stall-feeding of the cattle; it is so rich that hay is always mixed with it. After cutting, the water is again turned on for two or three days, and this is repeated at intervals of a fortnight or three weeks till the end of May or beginning of June, when the grass is cut for *hay*. After this crop has been got in, the land is left dry for ten or twelve days, when the same system of irrigation is again pursued, except that a somewhat longer period is allowed to elapse between each successive watering. The second hay-crop is generally cut in August; the land is then subjected to a similar kind of treatment, and the grass is cut for the fourth time about the end of September or beginning of October; and this last crop is also generally made use of for the stall-feeding of the cattle who are never turned out into the water-meadows. From this method of treatment it appears that four crops of grass are usually raised, and in very favourable seasons an additional crop may be obtained. The quantity of hay produced by an acre of water-meadow varies from 53 to 63 cwt.

Water-meadows are sometimes (I do not imagine the practice to be at all general) broken up after a period of four or five years, and potatoes, corn, clover, &c. are grown for a few seasons, when the land is again converted into water-meadow.

With regard to land where irrigation cannot be practised very much, the same system of cultivation is pursued as in the better managed farms in England—solid manure being applied in autumn, and liquid manure in spring and after each crop of grass. Liquid manure is mixed with water only in the very hot weather. I saw a field on M. Herzog's farm which he had already cut four times this year. There was then, September 23, a rich crop of grass which would be fit to cut in the beginning of October.

In the Canton of Berne the system of irrigation is not so generally or so exclusively employed. Through M. Zellweger's kindness I had introductions to M. Robert d'Erlach of Chateau d'Hildelbank, and M. Emile de Fellenberg of Hofwyl. M. d'Erlach farms at Hildelbank about 180 acres, 45 of which are arable and the rest grass-land. He pursues nearly the same system as that which I have already described as practised in the Canton of Aargau, except that after May he never leaves the water on the meadows during the day, but irrigates only by night. He does not often get more than two crops of hay, the first being generally cut in the beginning of June. He turns his cattle out

in the autumn, and does not feed them when in the stable with grass cut from the water-meadows, but with grass cut from the fields which have been manured. There is a spring on his estate which contains a large amount of carbonic acid gas; indeed the poor often drink it as a mineral water, and the water from this spring possesses remarkably fertilizing qualities. M. d'Erlach also told me that water which is previously useless for irrigation, after passing through mills or villages, generally becomes available.

I also paid a visit to M. de Fellenberg's farm at Hofwyl. This is situated on a conical hill, the sides of which slope gradually away. When the late M. de Fellenberg first came there this hill was little better than a swamp, while the low ground was frequently under water. Forty feet from the top of the hill there exists a stratum of gravel, at which depth springs were discovered. M. de Fellenberg conceived the idea of draining the whole farm, and applying the water which existed on the gravel bed to the irrigation of the sides of the hill. He formed drains mostly from 10 to 12 feet in depth, covering them above with flat stones, and filling them up with loose stones till within 3 feet of the surface, where he placed a layer of moss to prevent the soil from being carried away by the drains. A constant supply of water is derived by means of the drains constructed on the hill, and this water is collected in horizontal channels as it issues from the hill side, and is carried along the hill-side to the different parts of the farm. The water-course that conveys the water to the more distant localities is covered over, so that the water may not be affected by the temperature of the air; thus when applied to the land it is warm in winter and cool in summer. It is the intention of M. de Fellenberg to convert the whole hill-side into water-meadows: (part is now arable land.) To effect this, he removes the subsoil so as to make the surface even, taking care, however, to replace the surface soil: the subsoil so removed is exposed to the action of the air, and is then mixed with solid manure and applied as dressing.

M. de Fellenberg thinks that he cannot irrigate too much. I never saw fields look brighter or greener than the water-meadows on his farm; and the grass was thick, as M. de Fellenberg expressed himself, "like a brush." The greater the fall the quicker the grass grows (though I should observe that the fall was in no part very excessive). M. de Fellenberg irrigates as late as possible in the year, and only stops when there is danger of the water freezing in a mass on the land: as long as the water trickles underneath a surface of ice he continues watering, and considers that this surface of ice protects the roots of the grass. The water is made to flow over a certain portion of land for twenty-four

hours. It is then shifted further on, and in about a week they return to the point where they commenced. This shifting is occasioned solely by the scanty supply of water, and were there a sufficiency of water, M. de Fellenberg would let it flow constantly over the meadows, except immediately before cutting the grass. Irrigation is discontinued from the period when the severe frosts set in until such time as the snows have melted. Generally irrigation is recommenced in the month of March, and, as I have before stated, the extent to which the irrigation is carried is only limited by the supply of water. M. de Fellenberg generally has four crops of grass, the first and last are employed for the stall feeding of the cattle; the two intermediate crops for hay. Some years he has even had six crops of grass, and he recollects one year when the grass was cut for the cattle as late as Christmas. The first crop is generally cut in May, and the last crop in the end of October. The quantity of hay produced (as I was informed) per English acre is from 65 to 70 quintaux (somewhere between 64 and 69 cwt.). M. de Fellenberg finds it necessary, merely on account of manure, to keep from fifty to sixty cows. He farms about 280 acres, of which 90 are grass land. He also feeds the cattle during part of the summer with clover. The cattle are never turned into the water-meadows. Those meadows which cannot be brought under irrigation are manured with solid manure in the autumn; and should there not be a sufficiency of solid manure to spread over the whole, the remainder is watered with liquid manure *while the snow lies on the ground.*

In the farmyard are tanks in which every drop of liquid manure is collected. This is pumped up into a channel and conveyed by it to the water-courses, and thus with the smallest amount of labour some of the water-meadows are irrigated with water diluted with liquid manure. The grass from these parts is consequently richer and thicker, but the number of crops produced from land thus irrigated is the same as that which is produced from land irrigated with water alone.

There is a pump in the centre of the manure pile by which the drainings are pumped up every morning over and upon the manure pile, while part of the fluid is thrown over rubbish, potatoe stalks, &c. The hay was stowed away in large lofts above the cow-stables.

The whole farm was a most interesting sight, particularly when it is borne in mind that the enterprise and perseverance of one man has rendered what was formerly a marsh covered with coarse grass and rushes, one of the most productive and valuable farms in Switzerland. Nor were the immediate results of the late M. de Fellenberg's energy the most important. For the agricultural college and schools of Hofwyl have gained for their benevolent

founder a higher name than that of a successful agriculturist. These establishments are now carried on by his two sons, who also manage the farm entirely themselves.

I only wish I could have given a better or more worthy description of what M. Emile de Fellenberg was kind enough to point out to me. On parting, he observed that it was owing to the peculiarity of the position that they have been enabled to bring about such great results; and that their system could not be applied except in places as advantageously situated. Still he added that Hofwyl was a proof of what the energy and perseverance of one man could effect.

I shall be very glad if the few facts which I have collected, and I have attempted nothing more, are not altogether without interest to you; and I must thank you for the useful hints you gave me as to the points which would be most deserving of notice. The inquiry opened a most interesting, and to me a new field of observation, and added considerably to the pleasure of a vacation ramble, while through the kindness of Mr. Morier and M. Zellweger I had the good fortune of making the acquaintance of some highly informed Swiss agriculturists, of whose attentions I cannot be too sensible.

I remain, my dear Mr. Pusey,
Yours very truly,
HENRY T. J. JENKINSON.

23, *Old Square, Lincoln's Inn,*
Oct. 19, 1850.

XXXI.—*On the Advantages of using a proportion of Rape-cake as Food for Stock.* By J. H. CHARNOCK.

THE practicability of using a proportion of rape-cake beneficially as food for stock, and particularly for sheep, is deservedly attracting attention. The paper by Mr. Pusey, '*On the Use of Rape-cake as Food for Stock,*' published last year in the Journal (vol. x. part 1, No. 23), first introduced the practice to the agricultural public; and the infusion of the subject into the discussion on the management of stock, after the Council Dinner, at the recent meeting of the Yorkshire Agricultural Society at Thirsk, has given an additional stimulus to inquiry which may conduce to the earlier adoption of the plan. It was from the numerous and regular opportunities I enjoyed of witnessing the condition of the Holmefield flock at all seasons of the year, and more especially the progress of the fattening hogs, from weaning to the time of their going off fat, that I was induced to take part in the discussion at Thirsk by briefly and very imperfectly

describing the system which I had seen pursued with marked success, and which, somewhat to my surprise in such an assembly, was evidently regarded with that jealous feeling of distrust in novelties which proverbially—and, in many instances, wisely—characterizes the agricultural mind. It is, therefore, with suitable acknowledgments for the opportunity now afforded me through the pages of the Journal, that I purpose considering the benefits likely to accrue from the use of rape-cake as food. That we may proceed the more satisfactorily it will be requisite at this stage to place before the reader a copy of the letter, which, being too unwell to attend the meeting, Mr. Charnock addressed to the Secretary of the Society, on seeing the Report of the discussion referred to. And to render conviction the more complete, we may further premise that, so far from the Holmefield practice being adopted in consequence of Mr. Pusey's paper, it had been in full operation a year or two before that paper appeared; at the same time, it will be observed that, although at different periods, both gentlemen conceived the trial from the same source. Mr. Pusey says, "Having been informed by a French farmer that it is the practice in French Flanders to mix rape-cake with oil-cake, in the proportion of one to two, for the nobler purpose, &c." Mr. Charnock remarks, "I determined to try the effect of rape-cake on sheep, more especially as I had seen it given, to a certain extent, to cattle in the Netherlands."

Letter of Mr. Charnock to Mr. Milburn.

Holmefield House, near Ferry Bridge,
August 12, 1850.

My dear Sir,—Seeing in the newspapers that my relative, Mr. J. H. Charnock, has been explaining, at the Yorkshire Agricultural Meeting at Thirsk, my mode of feeding sheep, principally on rapecake, and perceiving that some doubts were expressed as to whether animals could be induced to eat rapecake, I hasten to furnish you with the particulars of my system, the results of which, in the shape of fat hogs, you last spring did me the honour to praise.

Let me premise my further observations by saying, although my land is of very inferior quality, I stock heavily.

I first commence teaching my ewes to eat rapecake at lambing time; but, from their now having had it the previous seasons, they eat it readily.

At lambing time the ewes have free access every night to troughs, in which is crushed rapecake, placed in the lambing fold. As the ewes lamb and go to pasture, the rapecake is continued through the summer at the rate of half a pound each ewe per day. At weaning time, about the middle of July, I take the ewes from the lambs, giving to the latter, on their old pasture, as much cake as they will eat, in proportion of one-third rapecake to two-thirds linseedcake. This proportion I continue until I remove them on to my second crop of clover, when I alter the cake to one-third linseed and two-thirds rapecake, which proportion I continue through the winter, giving them each half a pound of cake per day on

turnips, and always cutting their turnips from the commencement. In this way I find no difficulty in getting my flock to eat rapecake, if of good quality. There are certainly some samples of rapecake no animal can be persuaded to eat, such as have been heated on shipboard or in the warehouse, or have become fusty from being stowed in a damp room, or on a damp floor. I also find sheep prefer foreign to English manufactured rapecake. But sweet, good rapecake is not only readily eaten by sheep, but experience has proved to me it is a most healthy food for them. Since I began to use it liberally my flock has been much more healthy, and the deaths have decreased to a very small per-centage annually. The amount of deaths in my ewe flock, from October 1, 1849, to July 8, 1850, were barely $1\frac{1}{2}$ per cent.; and in my hog flock, from July 8, 1849, the time of weaning, to the date of their going to market, fat and clipped, were scarcely $1\frac{1}{3}$ per cent.

This small amount of deaths does not arise from anything peculiarly favourable in the season or in the plan of giving cake, for some very good sheep-farmers who reside near me, and who give their sheep quite as much cake per head annually as I do (but all linseed), were comparing notes with me the other day as to the advantage of using rapecake as part of the food of young sheep. They admitted their losses of lambs, both at weaning time and when putting them first on turnips last year, were very considerable, whilst I did not lose one lamb at either of these times. The principal cause of deaths in my hogs was apoplexy, from high feeding; but I find a regular supply of salt does much to check that disease.

One great claim which rapecake has to the attention of the sheep-breeder is, that not only does it check scouring, but it seems a complete preventive to that most fatal disease in newly-weaned lambs. Perhaps, if given with too much dry food, it might confine the bowels of sheep too much; but when given with very succulent food, it seems peculiarly adapted to prevent too great laxity.

The reason I first tried rapecake for sheep was from seeing the great good green rape did to young sheep; and considering that the seed of a plant contains the very essence of that plant concentrated, I determined to try the effect of rapecake upon sheep; more especially as I had seen it given, to a certain extent, to cattle in the Netherlands. Economy has caused me to persevere in it, as I find it by far the cheapest food I ever met with for sheep; and I find also, where cake is given to sheep on turnips, the succeeding crop of barley is better than if the same value in oats, peas, or beans had been given to them.

I gave 4 lbs. to 6 lbs. of rapecake each per day to 30 young heifers in my straw-fold last winter. They ate it readily, and did very well upon it, with a small supply of cut turnips.

I first persuaded my ewes to eat cake by sprinkling a little salt upon it. There is one thing which, however, it is almost needless to mention to you—that much of the success attending feeding sheep on cake depends on the shepherd's care, attention, and cleanliness. The troughs should be cleaned out daily, and the appointed time of feeding be strictly and punctually kept. The cake-troughs should be so constructed as to keep the cake from the rain.

Before I conclude, allow me to say that the plan of giving cake to my sheep all through the year is part of my system, on very light and naturally poor land, to manure directly for every crop; and I find passing highly-nutritious food through the stomachs of animals to be the easiest mode of applying the manure, and at a time and to a purpose when most needed. The young sheep, as a growing animal, is a great robber of your

soil, especially of the phosphates; it ought, therefore, to have them supplied in the food you give it, and you cannot supply them more readily, or at a less cost, than by giving rapecake, which contains more phosphoric acid than linseed-cake. The ashes of rape (green) are particularly rich in phosphoric acid, containing nearly 20 per cent.

Excuse this very rough and hurried scrawl.—I have no ends to serve.—If I can bring a cheap food into the notice and use of the agricultural world, I shall be satisfied; only you may rely upon my not riding my hobby further than it is profitable. I should certainly not have troubled you with this letter, had it not been for the discussion at Thirsk.

I am yours faithfully,

M. M. Milburn, Esq., Thirsk. CHAS. CHARNOCK.

As it is essential to the practical value of any experiment that it should be conducted on a sufficiently extensive scale, it may be right to mention that the flock on the Holmefield House farm comprises about 320 pure-bred Leicester ewes, and their progeny, usually numbering about 400, in addition: making a total during the greater part of the year of upwards of 700 sheep, out of which from 380 to 400 are annually sold off fat. Mr. Pusey's experiment was with a flock "of nearly 500 sheep;" and thus in point of numbers both must be considered sufficient; but the one flock being exclusively Leicesters, and the other chiefly half-breds, with a few Downs, and the success with both alike satisfactory, the general result must be deemed the more conclusive. If doubt can longer exist whether sheep thus treated will eat rape-cake, let those who are sceptical go to Holmefield and look for themselves; remembering that as with the human animal, "he was a bold man who ate the first oyster," so cake may "be caviare to the multitude" of sheep.

In the perusal of the letter we have given there are four leading features which present themselves for consideration:—

1. That the sheep have cake given to them all the year round.

2. That the health of the flock is above an ordinary standard.

3. That the subsequent corn crops are superior.

4. That by this system of feeding on the land (in contradistinction to fold and house-feeding) the cost of cartage to and fro is saved, and the manure distributed in the most uniform manner.

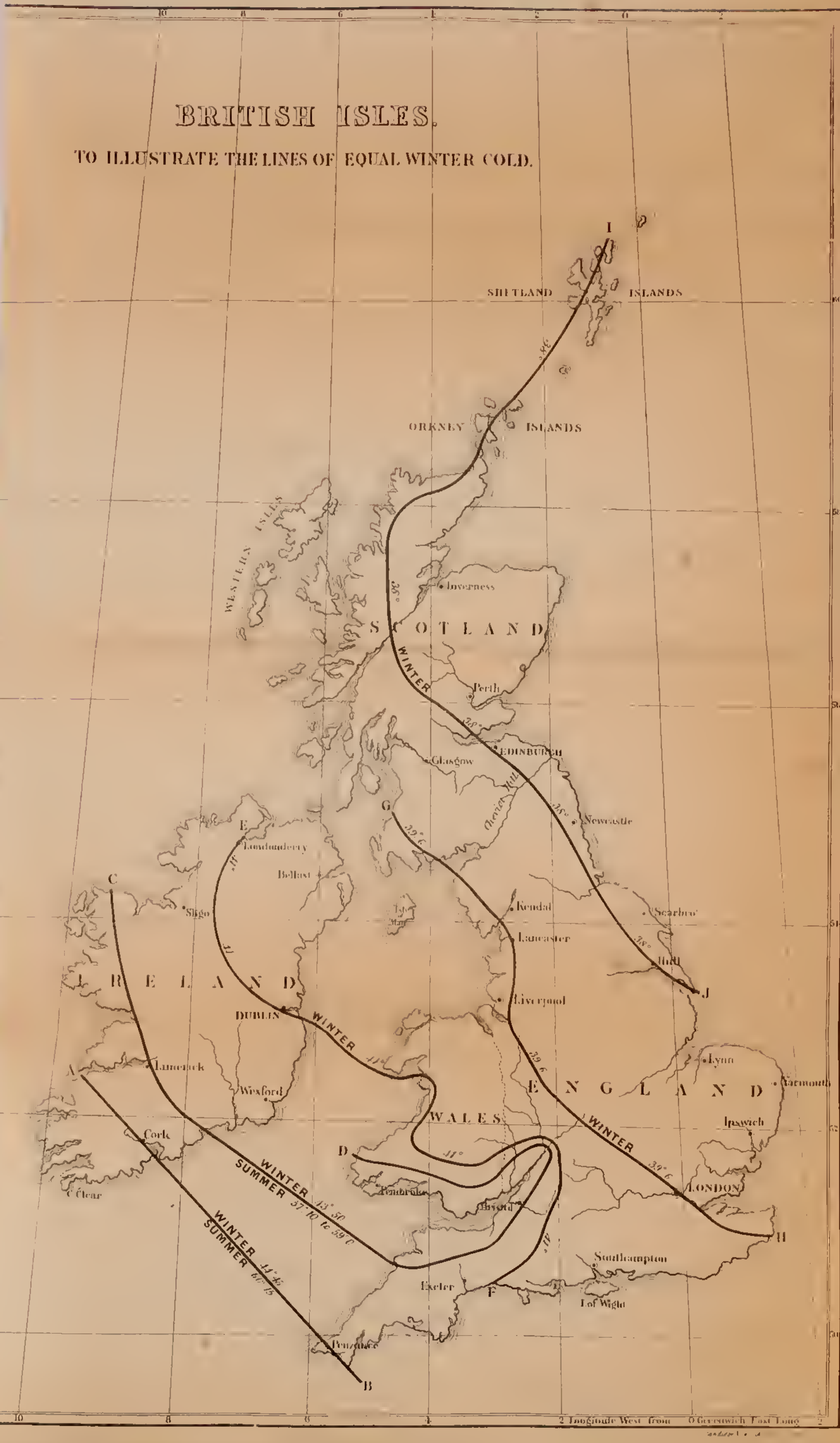
Now, by consuming cake on the land all the year round, each succeeding grain-crop obtains a share of the manure so made; the barley, after the eaten-on turnips, will have the benefit of about 6 cwt. of cake (rape and linseed) per acre; and the wheat, after the eaten-on seeds, will get about 2 cwt. per acre. Every farmer, from blind practice, knows the benefit to the following crop from the eatage on the land of green rape; and most

farmers also know that rape-dust is considered a very good hand-tillage for wheat. Why, then, should not a proportion of rape-cake, which, as Mr. Charnock observes, is but the concentration of green rape, produce corresponding benefits?

The same reasons will to a great degree account for the more than average health of this flock; the condimental properties of the rape-cake not only sustaining the vigour of the appetite, but correcting the succulent matter of the green food; so effectually, indeed, as to render it extremely probable that the use of rape-cake in situations where sheep are apt to take the rot, might very greatly modify, if it did not altogether prevent, this disease. I have noticed also the same outbreaks on the mouth and ears of some of the lambs, so common when feeding on green rape, which is strongly confirmatory of the value of rape-cake, as acting similarly on the sheep as the green rape. In what particular manner or degree cake-food influences the growth of young sheep we shall not attempt to determine; but that it does produce an earlier maturity of frame is evident, most probably through the agency of the nitrogen and phosphates, and also a corresponding increase of flesh and wool. The former possessing all those indications, in the colour of the mutton and gravy, which mark older meat, and the latter being, both in staple and strength, very superior.

It is not our present purpose to enter at any length on the comparative advantages of house or out-door feeding; we desire only as briefly as possible to submit whether an out-door system, such as has been described, is not more economical, and in every respect as efficacious, than feeding under cover, and thus necessarily involving a cost for cartage in and out that in our judgment is not sufficiently regarded by the advocates of in-door feeding. Of course with fattening cattle the in-door plan is indispensable; but it is not so with sheep, or with growing stock and pigs, all of which, by proper and suitable arrangements, may be advantageously kept on the land. As regards sheep, it is very doubtful whether the additional warmth when under cover, at all conduces either to the health or growth of the animal, and it is certainly prejudicial to the quantity and quality of the wool.

There is yet one other important consideration which, from the reproductive principles involved, possesses a primary influence in favour of a more liberal and general use of cake-food, and that is, the much greater number of sheep which it enables being profitably kept on a given extent of land. Before the introduction of the present system, it was with difficulty that a flock of 200 ewes could be sustained at Holmefield, and the fat hogs sold off in each year seldom or never exceeded 260. As also de-


BRITISH ISLES.
TO ILLUSTRATE THE LINES OF EQUAL WINTER COLD.
SHETLAND ISLANDS
ORKNEY ISLANDS
WESTERN ISLES
SCOTLAND
Inverness
Perth
EDINBURGH
Glasgow
Newcastle
Cheviot Hill
IRELAND
Londonderry
Belfast
Sligo
DUBLIN
Limerick
Wexford
Cork
C. Clear
ENGLAND
Kendal
Lancaster
Liverpool
Scarbro'
Hull
Lynn
Yarmouth
Ipswich
LONDON
WALES
Pembroke
Bristol
Southampton
I. of Wight
Exeter
Penzance
WINTER
WINTER 39°6
WINTER 41°
WINTER 43°50
SUMMER 57°10 to 59°0
WINTER 44°45
SUMMER 60°15
2 Longitude West from 0 Greenwich East Long.

serving of a passing notice, we would direct attention to the mode of weaning, the cutting of the turnips from the commencement, and the cleanliness and strict punctuality to be observed in giving the cake. The ordinary plan of weaning is to remove the lambs from the ewes, and put them into the best seed or clover fog which the farm affords, and which seldom fails to prove fatal to many of them. The other two practices are so obviously requisite to success, that we need not tax the patience of the reader by dwelling further on them.

I have only in conclusion to add, in order to show the liking which both sheep and other animals will acquire for rape-cake, that since the discussion at Thirsk I have seen 400 lambs, on luxuriant red-clover fog, daily eating with avidity their ½ lb. per head of cake, in equal proportions of rape and linseed; and that when last winter Mr. Charnock gave rape-cake to his young heifers in the straw-fold, two young colts soon became so fond of it that they drove the beasts away from the hecks, and were consequently obliged to be removed from the yard.

Wakefield, September, 1850.

XXXII.—*Climate of the British Islands in its Effect on Cultivation.* By B. Simpson.

The effect of climate on cultivation has not generally received that consideration amongst practical men which its great importance has long appeared to me to deserve. One reason of this, perhaps, is the slight knowledge of geography frequently possessed by farmers; and hence the comparative small knowledge of its effects on a large scale. To arrive at a knowledge of the effects of climate we need only look to the two extremes thereof, as witnessed at the equator and the poles. If we look from our temperate zones to the equator, we behold vegetation not only unchecked by the torpor of winter, but also aided by a large amount both of heat and moisture, spring up and progress with a rapidity and force unknown to us. There our plants rise to shrubs, and our shrubs become majestic and towering trees. Again, if we turn to the poles, we find our trees become shrubs, so small that several of them may be folded in the leaves of a book; and our plants entirely disappear.

By geographers this term is used as a subdivision of the zones, and the space from the equator to the poles is divided into twenty-four climates, having each a difference of half an hour in the length of their day, through the torrid and temperate zones, and of a month in the frigid. But climate is found to depend on

other causes as well as distance from the equator; and the popular sense in which climate is used has respect to every influence operating on the atmosphere. Thus we speak of climates as *hot* or *cold, humid* or *dry, varying* or *unvarying*, &c.; and it is the combination of effect produced by the whole of these and other agencies which constitutes the climate of any place. Climate, then, depends upon many causes, the principal of which are the following:—

1st. Distance from the equator.
2nd. A continental or insular situation.
3rd. Prevailing winds.
4th. The inclination of the land.
5th. Height above the level of the sea.
6th. The state of cultivation and drainage.

First.—Distance from the equator influences climate, inasmuch as at the equator heat and moisture, so essential to the vegetation of cultivated plants, are present in abundance; and this heat is present during the whole of the year, so that cultivation receives no check. There is no division of the seasons into winter, summer, spring, or autumn, and no period when the cultivation of the ground is prevented by frost. The only distinction of the seasons is into wet and dry. At the pole, on the contrary, the cold is too severe to admit of cultivation in any shape; and places between these are more or less favourably situated for cultivation, as they are nearer or farther from the equator.

Our islands lie between the latitudes of 50° and 60°, and are hence nearer to the pole than the equator, and have hence less than an average proportion of the heat requisite for vegetation.

Secondly.—A continental or insular situation. By a wise providential arrangement the density of water is greatest at about 40° of temperature; whilst its freezing point varies from 28° to 32°, according to its saltness, fresh water freezing at 32°, and salt water requiring a greater degree of cold in proportion to the more or less saline matter it may contain. Hence it follows that when the waters of the ocean fall below the temperature of 40°, or more correctly 39°·2, they will sink by their specific gravity, and the waters from below will rise up to supply their place: hence it is easy to perceive that until the whole column of water has been successively brought to the surface, and cooled down, the temperature will not fall much below 40°; and consequently very deep waters will never freeze, at least in temperate latitudes. Again, in summer, the surface of the water being heated by the rays of the sun, will hence be rarified, and have its density decreased; consequently the warm water will continue at the surface, and, were it not for the cooling effects of evaporation, would

be raised to a very high temperature.* The absorption of latent heat by the conversion of water into steam considerably modifies this; hence the ancient division of climates into insular and continental, the former of which are characterised as mild, and the latter as severe. Where places are situated remote from the ocean, and at a considerable distance from the equator, the rays of the sun falling upon the land, and being absorbed thereby, and accumulating at its surface, tend to raise the temperature very considerably; and there being but a short time during the night for the radiation of heat, considerably more heat is received by the land during the day than can be given off during the night, and a rapid accumulation thereof takes place; and thus the heat of summer at Moscow is found equal to that of the mouth of the Loire, though the latter is 10° degrees nearer the equator; whilst the average cold of winter at Moscow is greater than that of the extreme north of the coast of Norway.

A glance at the map of the world will at once show that the whole of Europe, compared with Asia, has an insular or mild climate, and that, compared with the rest of Europe, the British Islands experience this mildness to a far greater extent than eastern or continental Europe. Again, some parts of the British Islands experience this much more than others. Thus Ireland, the south-western parts of England and Scotland, experience this much more than the eastern parts of England, and through their whole extent the western parts being nearest to the Atlantic Ocean,† their climate is more equal than that of their eastern or central parts. But the greatest extent of land in Britain being on the south, and decreasing in extent, or being intersected by numerous inlets towards its northern part, it follows that though the average temperature decreases towards the north, from 52° at Penzance, to 50°·36 at London, 47°·84 at Edinburgh, and to 42° in the north of Scotland, yet this decrease is almost entirely owing to the greater heat of summer in the south and south-eastern parts, the winter temperature in the north of Scotland being nearly equal to that of London. Thus, whilst the temperature of the coldest month at London is 37°·76, that of the same month at Edinburgh is 38°·30; the mean of the three winter months being in the former place 39°·56, in the latter 38°·66 ('Encyclopædia Metropolitana,' article Meteorology, page 32); whereas the temperature of the summer months in

* This effect must probably be reversed by the amount of cloud proceeding from the sea, and other causes. It is stated further on, that in South Britain the land in the early summer months is heated more than the sea.—Ph. P.

† It seems quite established that the winter warmth of the western side of our Islands is due to the special warmth of the sea on that side, proceeding from the set of the Gulf-stream.—Ph. P.

London is 63°·14, and in Edinburgh 58°·28. We now come to speak of the next agent in the modification of climate, viz. :—

Thirdly.—Prevailing winds. And this subject, were the British Islands situated either in the centre of some vast continent or ocean, might be dismissed very briefly; but situated as they are near to a great continent on the east, whilst from a point of the compass, south by west, round the west to north by east, these islands are surrounded by a vast expanse of ocean, in considering their climate the direction of the winds is of the utmost importance: for were these winds generally from the north-east, east, or south east, then, notwithstanding our proximity to the ocean, our climate would be cold in winter; and the winds having passed over a large tract of land would be dry, though a portion of moisture might be absorbed by them on their passage across the German Ocean; yet owing to their previous dryness they would impart but little of either rain or dew to our island. Whereas, were our winds continually from the south-west, west, or north, charged as they would be by the vast quantity of moisture raised by evaporation during their passage over a great extent of ocean, they would impart a moistness to our atmosphere, which, though eminently favourable to the production of a luxuriant vegetation, and to the growth of grasses, trees, &c., would yet prevent the ripening of grain, and the general growth of those plants cultivated for the value of their seeds, or the ripening of their fruits.

Wind is air in motion, and this motion arises from two causes —*elasticity* and *gravity*.* Every one is familiar with the fact that heated air rises, and colder air rushes in to supply its place. Thus, as the heated air rushes up the chimney, carrying with it the smoke, a current rushes in through the chinks of the doors and windows to supply its place, and it was quaintly remarked by a writer on the great fire of London in 1666, that even the winds seemed to rush in from every quarter to augment its force. It is on the same principle that the cold air from the poles

* It may be useful to say that *elasticity* is the force with which air tends to expand itself, and it is increased by heat; as if any one fill a bladder with air and then place it near the fire, it will soon heat so that the elastic force of the air will burst the bladder. Now, it is evident that this elastic force of air will be greatest where it is the most heated, and consequently increases from the poles to the equator. But heat thus expanding air and making it occupy a larger space, necessarily causes it to be lighter bulk for bulk, and therefore its specific gravity is the greatest at the poles and decreases to the equator. Now in the free atmosphere each of these forces has its unlimited action, the elasticity tending to force the air from the equator, and the force of gravity tending to press it from the poles, and, did no cause interfere, there would always be a current of air near the surface of the earth from the poles to the equator owing to the force of gravity, and one from the equator to the poles in the higher regions owing to the force of elasticity. But the polar or north wind by the rotation of the earth is converted into a north-eastern, and the equatorial or southern is also changed into a south-western.

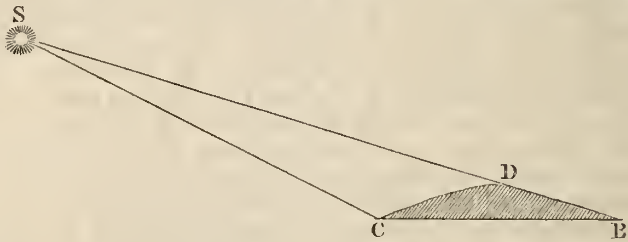
rushes towards the equator to supply the place of the air which by the action of the sun's rays is there continually ascending into the higher regions of the atmosphere.

The rotatory motion of the earth being much greater at the equator than near the poles, the wind cannot at once accommodate itself to the increased motion of the earth's surface towards the east, and consequently *lags behind*, and appears to move in a south-westerly direction, or from the north-east. The sea and land breezes also depend on the same principle: the land being more heated by the sun during the day causes a wind from the sea towards the land, but during the night the land being cooled by radiation there is a breeze from the land to the sea. The peculiar position of the continents of Europe and Asia causes *a land and sea breeze on a gigantic scale, having for its period not 24 hours, but the whole year; winter and spring answering to the night or land-breeze, and summer and autumn answering to the day or the prevalence of the sea-breeze.* Thus, according to the intensity of the sun's rays on the vast continent of Europe and Asia during the summer will be the regularity of the westerly and south-westerly winds during summer and autumn; and in proportion to the cold of winter on the same continent will be the regularity of our easterly and north-easterly winds during winter and spring. Except, owing to local peculiarities, the former of these winds (the western) is so regular that from June to November there is rarely for two days together a wind blowing in any other direction; and that the latter, the eastern winds, are fortunately not equally regular is owing to the current of air from the continent setting strongly towards the equator across the Indian Ocean causing the monsoons, and this air, on arriving at the equator, being heated and rising till its elasticity overcomes the density of the air near it, it flows back in an upper current towards the poles. But coming from the equator, its motion of rotation is greater than that of the air farther from the equator, and thus it will apparently have a motion from west to east, and when, by being condensed by the cold of the upper regions, it falls down to the surface of the earth, its motion will counteract the regular motion from east to west, and cause variable winds, which are hence far more common during winter and spring than during summer or autumn. In Scotland, especially on the Highlands, the winds are extremely variable, yet the general tendency along the western isles, also along the western coast, when they have not been interrupted by the mountains of Skye, and in the Shetland and Orkney Islands, is for fully two-thirds of the year from the west. But among the Highland mountains, when any of the valleys are heated by the rays of the sun, the wind rushes with violence through the

narrow passes and glens, often attended by storms of snow or rain.

The next thing I have mentioned as influencing the climate of any country is—4th. Its general inclination. Every one is familiar with the fact that frost or snow continues much longer on the north and north-eastern side of a building, a fence, or a hill, than it does on their southern or south-western side. On a more majestic scale this is seen on the northern slope of the Altaian Mountains, contributing to the frosts of Siberia; also in Switzerland, where the south and south-western sides of the Alps are clothed with vineyards, whilst the north and north-eastern are covered with perpetual snow.

The reason of this will be evident on an inspection of the following figure. Let S represent the sun, and C D B the



section of a mountain. Then it is evident that the rays of the sun which would be spread over the space C B, if it were a level surface, will fall exclusively upon the south side, C D, which being shorter would be warmer than the level surface, while in the extreme case supposed none will reach the north side, D B, which would therefore be chilled. But during summer the sun would, after passing the west, be lost to the south side of the mountain, so that a partial loss would there take place; an aspect therefore turned partially to the west is preferable, for it is better to lose a portion of the morning rays of the sun than those of the evening. The inclination of a country is best known by the direction of its rivers. The general inclination of the British islands is east by south, with a range of mountains running north by east along their western sides, and generally sloping abruptly to the west by north. This arrangement has a great effect on the climate of the British Isles. The large quantity of vapour contained in the winds which have crossed the Atlantic Ocean is condensed by crossing their summits and falls in rain on these hills and the neighbouring plains. This condensation of vapour, too, by giving out a large quantity of latent heat causes a temperature much higher than from their elevation we should otherwise expect, and renders those hills generally well fitted for maintaining vegetation.

To the above general results there are of course endless variations, indeed the extent of a single farm will frequently offer examples of almost every inclination. Some of the more striking exceptions I may name. In Ireland, nearly the whole of the counties of Kerry, Clare, Limerick, and Sligo, slope to the west; whilst Londonderry and Antrim slope generally to the north. In Scotland, Dumfriesshire, Kirkcudbright, and Wigton, incline to the south; whilst Lanarkshire, Argyleshire, and a great part of Renfrew slope towards the west. In England, most of the counties bordering on the British Channel with Monmouthshire and Herefordshire slope to the south, whilst Cumberland, Lancashire, and Cheshire slope generally to the west.

The 5th cause of the modification of climate, viz. height above the level of the sea, will be treated of when we come to speak of the "Effect of Elevation on Temperature and Lateness of Harvest," &c., to which it properly belongs.

6th. The effects of cultivation and drainage are subjects of vast practical importance. With respect to the preceding causes which modify climate, though it is well to know them, that we may not *oppose*, but act in *unison* with nature, yet *their* influence is generally beyond our control; but these last are to a great extent in our own power, and so far as their influence extends man makes a climate for himself. When we consider that it is mainly owing to the increase of heat that the vegetation of the tropical regions is so luxuriant, and to its absence that the frigid zone is so sterile and unproductive, it becomes important that none of the heat imparted to our soil should be wasted, but rather husbanded with a care equivalent to its beneficial effects in increasing the productiveness of our soils.

Now, all the rain that falls upon our fields must either be carried away by *natural* or *artificial* drainage, or, having thoroughly saturated the soil on which it falls, be left upon the surface to be carried off by evaporation. Now, every gallon of water thus carried off by evaporation requires as much heat as would raise five and a half gallons from the freezing to the boiling point! Without going to extreme cases, the great effects of the heat thus lost upon vegetation cannot fail to be striking, and I have frequently found the soil of a field well drained higher in temperature from 10° to 15° than that of another field which had not been drained, though in every other respect the soils were similar.* I have observed the effects of this on the growing crops,

* Since writing the text, I have read, in the 'Quarterly Review,' an article on Draining, and in which I find the writer takes a similar view of the bad effects of leaving land undrained; and states, that 1 lb. of water evaporated from 1000 lbs. of soil, will depress the temperature of the whole 10°. Now, the temperature of the ground 3 feet below the surface in England is rarely more than 46° to 48°; and hence rain falling during summer often of a temperature of 60° to 70°, raises the temperature.

and I have seen not only a much inferior crop on the undrained field, but that crop harvested fully three weeks after the other, and owing to this circumstance and the setting in of unsettled weather (which frequently in our climate does set in about the autumnal equinox), I have seen even that crop deteriorated fully ten per cent. in value.

We may now proceed to the "*Increase of winter-cold in passing from south to north, and from west to east.*"

From the accompanying map, the lines of which are drawn to illustrate the increase of winter-cold, it will be evident that the cold of winter increases from south-west to north-east, while the cold on the eastern coast is nearly the same during winter in the south as it is in the north. The reason of this apparent inconsistency I have explained. With respect to the authority for these lines. I may state that they are based on my own observation, aided by the results of observations recorded in the Philosophical Transactions, the Metropolitan Cyclopædia, the Edinburgh Philosophical Transactions, with the works of Daniel, Howard, Humboldt, &c. In addition to the above authorities and my own observations, I have been, where I had any doubts, much obliged by the kindness of friends living in the different localities who have assisted me; and where I had still doubts, I have calculated, by the formulas of Playfair and Atkinson, what, according to the position of the places, the temperature ought to be; and if these results have not accorded with observations pretty nearly, have rejected both.

I need only add now, in explanation, that the first line of 44° 45′ winter-cold is drawn arbitrarily as respects the part of the ocean it is made to pass, I not being in possession of any observations made in that part of the ocean. With respect to the line C D of 43° 50′ of winter-temperature, it appears very irregular in passing Cornwall, Devonshire, &c., and then bending back along South Wales, so that North Somerset is warmer than South Devon; but the reason of this will be evident when the warming effect of the Bristol Channel is taken into account, also the shelter afforded by the mountains of Wales. I need scarcely add that all these lines are intended to apply to the level

of the soil as it filters through to the drains; and this is, doubtless, one reason of the fact I have often proved of the higher temperature of the soil in drained than in undrained land. It also appears, from experiments made by Mr. Parkes at Chatmoss, that the temperature of the drained soil averaged 10° more than that of soil undrained. Owing to the cause before stated, the temperature of the soil in drained land was found greatest after a shower. This was, doubtless, owing to the greater temperature of the water carried down into the soil. This, as the article quoted states, is a reason of the comparative luxuriant appearance of wheat in undrained land during winter, for then the water in the land is of a higher temperature than that falling in rain, and the drained land is then colder than undrained. It appears that this winter warmth and summer cold is remarkably unfavourable to the growth and ripening of grain.

of the sea, and that by winter I understand the months of December, January, and February. It is important that whilst vegetation during nine months of the year in the middle and eastern parts of England, is liable to a cold below the freezing point, during the night—in places situated south-west of the line of 41° winter-cold, they are not liable to a cold so severe during more than four months of the year. On this account, many tender plants, as the myrtle and camellia, natives of southern Europe, flourish in the open air in some parts of Cornwall and the south-west of Ireland. On the same account it is that the growth of artificial food for cattle is much less imperative there than in the eastern parts of England, grass growing all the year round in those districts.

In entering upon the next subject, viz., "Different distribution of heat in the various seasons of the year," the force of the preceding observations will appear more evident. From what was before stated, the reader will be prepared to hear that during the coldest month of the year *London is colder than the Orkney Islands,* whereas in the warmest months it is full 20° warmer—the extreme range of the thermometer being only 27° in the Orkneys, whilst the annual range at London is from 20° to 81° of Fahrenheit, or 61°.

With respect to mean temperature, it may be useful to some to remark that it comprises very opposite states which may be very differently distributed. At one period of the day in summer, from noon to 3 P.M., we may have a temperature of 81°, equal to what they have at the equator, and at midnight one of 40°.

The general mean temperature of any place is made up of *the average of those of day and night* for each day; again an *average* of these *averages* for a month; the average again of three months, for winter, summer, &c.; and again an *average* of these for the mean of the year. If the above were not the case, cultivation would be altogether different. Were the mean temperature of a place that of every day and hour through the year, then we should have perennial spring—trees and shrubs that would vegetate would be evergreens; grass and our numerous roots would grow equally well at any season, but corn would never ripen. In England we should have strawberries, raspberries, and a few other fruits, but none else would ever come to maturity, aud it is easy to see that we should be losers by the change. Since the distribution of heat through the seasons then is so important to cultivation, I will now state that distribution in the British Islands, leaving generally the discussion of its effects on cultivation till I come to speak of the effect of climate on different cultivated plants, &c.

First, as it respects the distribution of heat through the day, I

have found from many experiments the minimum of heat for the twenty-four hours to be from 1 h. 30 m. to 30 m. before sunrise, and the mean to occur 48 m. before the rising of the sun. It would appear from my own observations that the greatest cold is found nearer to the time of sunrise in summer than in winter. The maximum of heat is found upon an average of many years to occur from 2 h. 30 m. P.M. to 2 h. 45 m. P.M. The mean temperature of the day is generally approached at about half the time from sunrise to 2 P.M., and again about an hour after sunset. The variations of daily temperature have a great effect on vegetation; from my own notes, they are, in the midland counties, the least in November, December, and January; the mean difference between the maximum and minimum being for January, 7°; December, 6°; and November, 5° 30′. The mean difference is the greatest in March, April, and September; the mean variation being for March, 20°; for April, 18°; and for September, 19°; the remaining months being, August, 16°; May, 15°; June, 12°; October, 12°; and February, 9°. The decrease in heat during the night being evidently owing to the radiation of heat from the earth, it is much the greatest in cloudless and windy weather, these being favourable to the radiation of heat. In cloudy weather the radiation of heat is checked, and the heat is radiated back by the clouds, so that the difference between the maximum and minimum temperature of very cloudy days and nights is frequently not more than 3° or 4°. Taken in this view, the distribution of heat through the day is of a very fluctuating kind, yet there is a surprising regularity in its general laws. When I come to speak of the distribution of vapour, it will be made clearly to appear that February, March, April, May, and June are the most free from vapour, clouds, &c., and it will be seen at once from the above that the average *variation* of temperature is greatest during these months when compared with others of equal temperature. November and December are the most foggy months, and January the coldest; and we find, on referring to the above averages, that the variation of temperature is least during these months. Other things being equal, the more aqueous vapour there is in the air, the less will be the difference between the temperature of the day and night. Westerly winds also cause a less variation than easterly, hence in May, 1848, with easterly winds and clear weather the difference averaged nearly 36° during the month. On the western parts of the British Islands, especially south-west of the line of 41° winter-temperature, the variation between the temperature of the day and night is much less (in many places by one half) than in the midland counties, whilst in the eastern counties the average difference is somewhat greater. Thus we may infer another general law in-

fluencing the distribution of heat in our climate, that the less difference there is between the *summer and winter* temperature of any place, the less difference there will be between its highest and its lowest *daily* temperature. For the general purposes of meteorology, the temperature is determined by thermometers in the shade, but the direct radiation of heat by the sun has a powerful influence in maturing fruits and the seed of plants, and this direct influence of the sun is greatest at the time when the sun is farthest north of the equator, viz., the 21st of June, and least on the 21st of December. The temperature of the soil for two or three feet below the surface influences the growth of plants, for the juices of plants are absorbed by the roots, and they take up their food much more readily when the temperature is high, just as sugar or salt will melt in warm much sooner than in cold water; and when the ground and the moisture near the roots of plants are frozen, they must cease to vegetate, as no moisture can then be imbibed. The surface of the soil generally averages through the year 2° to 3° *more* than the air, and arrives at its maximum in August, and its minimum in January. The soil is rarely frozen more than two or three inches below the surface.

In giving the *mean* temperature of each month it will be necessary to state the greatest *variations* in the temperature of that month in *different seasons,* letting it always be borne in mind that this variation is greater on the eastern than the western coast. January has a mean temperature varying from 42° in the south-west of Ireland and Cornwall to 34° on the eastern coast, and varies during different seasons as much as 6°, being sometimes 3½° below, and sometimes 2½° above the mean. The coldest instances within my recollection occurred in 1838 and 1820, and the warmest in 1834 and 1846.

February has a mean temperature, varying from 45° in the south-west to 38° in the north-east. In 1846 this month was generally 3° to 4° above the average. In 1847 and 1838 it was nearly 2° below the average. Hence its range of temperature from the mean appears to be 4° above, and 2° below the general average temperature.

March has an average of mean temperature varying from 48° to 40° in our islands, and varies from its mean temperature as much as 4°. It was warmest in 1841 and 1846, and coldest in 1837 and 1845. About the middle of the month, in 1845, the thermometer fell to 6°, the lowest I ever observed in this month.

April is an important month with respect to vegetation, the revival of nature usually taking place at this season. The temperature of this month generally approaches nearly to the mean of the whole year. In the south-west of Ireland and Cornwall its mean temperature is 50°; in Lancashire and Cheshire 51°; but at London 49°; and at Edinburgh only 42°. Its temperature varies

during different seasons about 3° from the mean, which for the whole of the British Islands may be about 47°. It is during this month that a change takes place in the relative temperature of our western and eastern districts; for whilst from September to April the western, and during the months of December and January, even the northern, had a higher temperature than the south-eastern parts, from April to September the eastern and south-eastern have a much higher temperature; the maximum of their higher temperature as compared with the western and northern parts occurring in July. No month is exposed to equal extremes of heat or cold with April; a change of wind from the south-west to north-east will frequently cause a difference of 50° of temperature in twenty-four hours; and one or two nights will often destroy the fairest prospects of the horticulturist, and scatter the buds and blossoms of our fruit-trees after we had fondly hoped all danger was past. The maximum heat on record for this month is 81°: it occurred in 1840 on the 26th. The lowest usual range is 28° to 30°; but it was as low as 23° in the midland counties in 1838.

May has a temperature varying from 54° in the south-east to 42° in the north. North-east winds generally prevail, and the changes of temperature are great during the month; yet its general average rarely varies more than 2° from the mean. This month is more ungenial in our climate than most of the others. This is owing to the east winds, which are during this month dry and cold; and during this month the most sensible difference in vegetation and the heat of the soil is observed. Where the land has been deprived of its surplus water by an efficient drainage vegetation progresses rapidly, but when the water has to be evaporated, languishes; wheat especially turns yellow, and rarely ever recovers the check thus given to its growth.

June has a mean temperature, varying from 62° in the south to 50° in the north, and in Ireland from 59° in the south to 55° in the north, its temperature being generally higher in the eastern than in the western counties. At the Orkney Islands, the *middle of June is frequently nearly as cold as March*, owing to the prevalence of cold northern winds; and it is not till the latter end of this month that vegetation makes much progress in those islands. The temperatures of July and August are nearly the same, the average being about 2° above that of June. During September the western parts of the British Islands have a higher temperature than the eastern, and during the whole of autumn that superiority is maintained. September has generally a mean temperature of from 58° in the south-east to 60° in the south-west, and 50° in the north. During this month the temperature of the soil is frequently as high as during any other month of the year, but for which many crops would never arrive at maturity

in the north of Scotland. The temperature of the soil at 12 inches below the surface generally attains its maximum in September, and is frequently 5° higher in well-drained land than on the surface, and at the surface 2° higher than it is in the air. The temperature of the air frequently suffers a great diminution about the 21st of this month; and almost every year stormy weather is experienced between the 21st of September and the 3rd of October; and I have frequently seen corn that was not carried before the autumnal equinox still in the field during the middle of October. This month had a temperature of 5° above the mean in 1846.

October in its general mean temperature again approaches to the mean of the year, being somewhat lower than the mean in the south-eastern and midland counties, and higher in the west and north. After the first week of this month the weather is commonly fine; and during the whole of it the temperature of the soil is much higher than that of the air. In the south-west of Ireland and of England the average temperature is 52°; in the eastern and midland counties 48°; and in the north of Scotland 47°.

November has a mean temperature, varying from 46° in the south-west to 41° in the south-east, and 42° in the south-west of Scotland to 40° in the eastern parts. There is less variation between the day and night in this and the following month than in any other during the season: the usual range of the thermometer is from 54° to 29°.

The mean heat of December is 46° in the south-west, and 38° in the south-east, and is but little below the latter temperature through the whole of Scotland. In the south-western parts of the British Islands vegetation goes on during the whole of this month; and persons visiting Ireland may perceive by the greenness of its pastures, that it deserves the name of the Green or Emerald Isle. It is proverbial in the north of England that cold sets in at Christmas; and very generally it is during the last week in December that real cold weather begins. The lowest temperature on record was on the 25th, in the great frost of 1795-6, when it sank to zero. The usual range of heat during this month is from 50° to 20° of Fahrenheit.

I now come to the third subject, viz., "Different amount of *Insensible* Vapour in the Atmosphere on the Western and Eastern Sides of England and Ireland."

This part of the subject has been partially anticipated; and that the following remarks may be fully understood, and consequently really useful, I shall in the first place explain, as briefly as may be, the laws on which the formation of vapour and its presence in the atmosphere depend.

The earth is surrounded by two atmospheres—one of air, and

the other of vapour, each of these being governed by its own laws, and exerting no effect upon the other save that of a mechanical resistance when in motion in opposite directions. Every one is familiar with the fact that water when sufficiently heated has a tendency to fly off in steam, and also with the fact that this tendency is greater as the temperature is increased. That this tendency is very great in some cases is proved by the fact that if this vapour is not permitted to escape with sufficient rapidity, its force is sufficient to burst asunder the strongest boilers. But it has only recently become known that water at all temperatures, even below the freezing point, has a tendency to give off vapour or steam. Now it being known that water has this tendency to form and throw off vapour, it follows that it will always do so unless prevented by some cause. Thus at the temperature of 60° water has a tendency to throw off vapour of an elastic force equal to 0·524; and if nothing counteracted this tendency, water of that temperature would continue to give off vapour of that force, and in a still atmosphere would, from a vessel 6 inches in diameter, convert into vapour 2·1 grains of water every minute. But if, instead of there being nothing present in the atmosphere to counteract this tendency, there was already vapour in the atmosphere having an elastic force of 0·263; then the tendency to form vapour, viz., 0·524, would be opposed by a force of 0·263, and the real resulting tendency would be the difference, or 0·261, and the water evaporated from a similar vessel, instead of 2·1 grains, would be only 1·045 grain per minute. Again, it is evident that if the force of the vapour in the air was equal to the evaporating force of water, then no evaporation would take place, and the air would be what is termed saturated with moisture, that is, unable, without an increase of temperature, to receive any more. It is also evident that were the temperature by any means lowered, the force of the vapour would be greater than the force of water to form it, and to restore the equilibrium a portion of the vapour would again be precipitated on the surface. The point at which this condensation takes place is called the dew point. This point, when the air is saturated with moisture, is evidently the same as the temperature of the air; but when the air is not thus saturated, it will be below that temperature. Thus, supposing the heat of the air 60°, then, as before, the force of vapour is 0·524; but if vapour exist in the air of an elastic force equal to 0·375, then, as we find from a table calculated for the purpose, that it requires only a temperature of 50° to give off vapour having this force, the air might be cooled 10°, or from 60° to 50°, without any condensation of vapour taking place, but the least decrease below this point would be followed by condensation, or the conversion of a part of the vapour into water.

Now as the air is rarely saturated with moisture, and consequently, from what has been stated, the elasticity of the vapour existing in the atmosphere being below that due to the temperature of the air, but always equal to the elastic force of vapour at the dew point, to determine the dew point becomes necessary. An instrument for effecting this was contrived by Dalton, extremely simple in its arrangement. He poured water of a temperature below that of the atmosphere into a very thin glass tumbler; if dew immediately formed on the outside of the glass, he poured in a little warmer water, till dew just began to form. All that was then necessary was to determine the temperature of the water by the thermometer, and hence the dew point; for the point at which dew was formed was evidently the temperature at which the vapour had assumed the aëriform or vaporous state. I need scarcely add, that the difference between the dew point and the temperature of the air is a measure of its dryness, and that the greater the difference between these points the less probability of rain: and in the months of May and June, when the advantage of a moist atmosphere is so important to the success of the turnip crop, if the dew point is not more than 5° or 6° below the temperature of the atmosphere, turnips may safely be sown; for though rain may not fall, yet the soil will imbibe sufficient moisture from the air for the successful germination of the plant. I shall now proceed to give the dew point, on the average, for the eastern and western parts of the British Islands; but as these results can only be general, I would strongly urge all farmers to make use of the above simple process to determine it for themselves. I may add, that a dew point 6° below the temperature of the air has been considered an average; therefore a greater difference than this indicates dryness, a less wetness of the air. I may also add, that the quantity of evaporation increases with a decrease of pressure, and consequently at a height of about 15,000 feet is increased by one-half, or water will at the same temperature give off twice as much vapour as at the level of the sea. Mountains are always more humid than valleys, and the air nearer the point of saturation. This is one reason why much more rain falls in elevated places than at the level of the sea.

From the following table, which may give a general idea on the subject, and which I have made as correct as possible, it will be seen, by comparing the figures with the temperature of the different months, that the air is much more saturated with moisture during the months of November and December than in those of corresponding temperature, viz., February and March. Also, that generally there is, as had been before inferred, much more vapour present in the air during summer than winter, and during

the autumn than the spring. There is always much more moisture in south and westerly winds than in north or easterly, yet to the eastern shores an easterly wind may bring more moisture than a western, for western winds have always a great portion of their vapour condensed in passing over the mountainous district on the west of our islands.

Average Dew-point on the Eastern and Western parts of the British Islands for the several Months of the Year.

	Eastern.		Western.	
	North.	South.	North.	South.
	°	°	°	°
January	30	31	31	40
February	30	31	31	40
March	33	35	34	44
April	40	43	41	47
May	41	46	41	47
June	48	51	50	56
July	50	53	51	58
August	51	56	52	58
September	49	54	50	56
October	43	47	43	50
November	39	43	39	46
December	32	34	32	42

Intimately connected with this subject is the next subject proposed, viz.—4th. Different amount of sensible moisture or fogs.

With every respiration men and animals give out a quantity of moisture, which is generally invisible; but if the air be very cold, or the animal heat much increased by active exertion, then this moisture is visible. The cause of this is in both cases the same: in the former case, when the atmosphere is very cold, men and animals give out vapour whose tension being greater than can be maintained by the temperature, it is of necessity partially condensed and made visible: in the latter case also the heat of the body is raised by exertion, so that the moisture given out is equally condensed. With respect to mists or fogs and clouds, they are every way similar, except in their height from the ground. When vapour rises from moist earth or water, it ascends on account of its specific levity, till it is condensed by the cold of the upper regions and forms clouds; but should the temperature of the air be on the surface lower than that of the earth or water on which it rests, then condensation must immediately take place, and the result be the formation of fog or mist; the former term being generally applied to vapour from the land, the latter to vapour from the water. Fog may also be formed by the air at some distance from the ground being cooled below the dew point, especially if this cooling is rapid, for then the air

immediately in contact with the land will form dew; but the air not thus in actual contact with the land will have its moisture condensed, and a mist be formed, which will appear to rise gradually as the air is cooled farther from the ground. It will thus be evident that fogs will be more frequent when the air is nearly saturated with moisture, a slight cooling thereof then causing condensation. They will, for the same reason, be more common in marshes and damp situations, on account of more vapour arising from these than from drier localities. Hence the reason of their frequency in autumn, for then the air is near the point of saturation, and during the night generally sinks below that point. Hence also their frequency, especially during autumn, in the neighbourhood of rivers and lakes; for the water, not cooling so quickly in the evening as the land or the air, gives off vapour which is immediately condensed and forms mist. I have frequently watched its formation and seen it gradually arise as a slight haze on the surface of the water, and slowly rise higher and spread along the course of the river as far as the eye could reach. I lived for many years near a large lake surrounded by hills, and I have watched it thus by the light of the moon gradually rise and spread through the entire valley, and in the morning I have frequently followed it as it retired up the hill and cleared away when the temperature of the air rose higher than the temperature of the lake at the time of its formation. I remember well that, not being then acquainted with the subject so well as now, I wondered why the vapour did not first disappear where it had been last to form, viz., on the upper part, instead of the lower; but the thermometer assigned the true reason—it disappeared at any place when the temperature reached the dew point, and this was reached naturally in the lower sooner than the higher situation, unless a current of wind interfered to disturb the natural tendency.

Fogs and mists may then naturally be divided into two kinds, essentially different in their origin. The first kind arises from the cooling of air saturated with moisture. The second arises from vapour ascending from water of a higher temperature than the air, which hence becomes condensed as it is given off from the water, and spreads more or less over the low grounds adjoining the rivers, seas, or lakes, which supply the vapour.

The first kind occurs most frequently during the night, and continues till dispersed by the sun in the morning. It is more common from September to January than during any other season, November being the month it most prevails in; the reason of this being, that during these months the air is most saturated with moisture, and during the night is generally cooled below the point

of saturation, when a portion of the vapour becomes condensed and forms fog or mist. This is more common, too, in places elevated above the level of the sea, and on mountains than on plains; and, as far as I have been able to determine, more dense generally where places rise 300 to 600 feet, than on the low ground, or at places whose elevation is greater. This kind of fog abounds most in the western and northern parts of our island, and, being caused by the same influences as cause rain, is most common where most rain falls; and hence a very accurate conclusion may be come to respecting the prevalence of this kind of fog, by perusing and marking the distribution of rain as recorded in that part of this Essay relating to that subject. I may also remark that *by far the greatest quantity of the rain that falls during the autumnal and early winter months falls during the night and early part of the morning;* for the vapour being then condensed into fog, if any cause tending to a further condensation occur, rain is sure to follow; whilst, when the moisture is invisible, and the capacity of the air for moisture is increasing, it requires a greater depression of temperature to cause rain, and consequently less rain falls during the day than night.

In the western parts of England and Ireland, during the months of October, November, and December, this kind of fog occurs on an average two nights out of three, less or more. On the eastern parts about half the nights may be free from fog; but it occurs also more frequently in the northern than the southern parts of our islands.

The second kind of fog is different in its origin from the preceding kind, and different laws govern its distribution in any locality. If its source be a river or lake, it will abound in the immediate locality of its cause, and will follow the windings of the river, or extend along the low ground adjoining the lake, and will always exist more or less whenever the temperature of the water is much higher than that of the air. If this fog arise from the sea, it may extend much farther, and in particular seasons be much more regular in its recurrence, than when its source is more confined. A remarkable instance of this occurs in what is termed the *Eastern haars*, which occur during the spring and early summer months on the eastern coast of Scotland and the northern parts of England. The German Ocean, being comparatively narrow, is raised in temperature more easily than the Atlantic, and hence during the early part of summer and spring a rapid evaporation takes place from its waters. Now the same cause which tends to raise the temperature of the German Ocean also tends to raise that of the land. But the land is here narrow and elevated, so that the vapour is condensed on crossing the land,

and a dense fog is formed, which extends to the westward till it comes to the mountains; and after crossing them, the heat being raised, the fog is dispersed, and the western parts are clear and serene. These fogs used to cause ague and other diseases, but the progress of cultivation has caused those diseases to disappear. The reason why the same cause does not occasion fog in the southern part of Britain is, that there the land, being lower, is heated even more than the sea, and consequently the air in passing over it becomes heated, and instead of having its vapour condensed in fog, it becomes able to hold still more vapour in an invisible form. Another cause of this difference is the narrowness of the German Ocean along the southern shores of Britain, which does not admit of the wind imbibing so much vapour in its passage across as it does more northward. During the spring and early summer months, then, fogs are more prevalent on the eastern coast of Scotland than the western; but this cause has a limited influence on England and Ireland. In the autumn the Atlantic has a temperature higher than the land; hence along the whole western coast fogs are prevalent during this season, and these fogs continue often for weeks together, especially in the western parts of Ireland, the air being very rarely quite clear; but a kind of cold moist haze overspreads the whole country during the autumnal months, whilst the eastern parts are comparatively clear except during the night. In Scotland, particularly in the northern parts, a blasting kind of fog frequently spreads along the banks of rivers and along the low ground, which causes great damage to the corn crops, frequently doing irreparable injury to barley, and causing it to turn black, whilst it leaves the oats, on account of their greater hardihood, comparatively unaffected.

I now come to the next subject, viz., "5th. Different degree of general Cloudiness of the Sky."

Intimately connected with this subject is the evaporation from the surface of the earth; and from what has been stated in the preceding article, it is evident that the more moisture there is in the air, the less evaporation there will be from the surface of the earth, but the more cloudiness of the atmosphere. Thus the evaporation will vary inversely as the atmosphere is more cloudy, and the evaporation will be the least when the cloudiness is greatest. Due allowance must of course be made for difference of temperature. The cloudiness will be greater, and the days in which rain falls the more frequent, as the temperature is the lowest. Column 1st in the succeeding table gives the month; 2nd, the evaporation from a surface of water in the western, and 3rd, that in the eastern counties; column 4th, the rain in the west; and 5th, rain in the eastern parts.

1.	Evaporation from a Surface of Water. West. 2.	East. 3.	Rain. West. 4.	East. 5.
	Inches.	Inches.	Inches.	Inches.
January	0·4	0·6	3·5	1·5
February	0·9	1·2	3·0	1·3
March	1·5	1·9	1·8	1·1
April	2·0	2·4	2·2	1·3
May	3·1	3·8	2·4	1·6
June	3·4	4·2	2·5	1·7
July	3·0	3·6	4·1	2·4
August	2·7	3·4	4·5	2·0
September	2·2	2·6	4·0	2·1
October	1·3	1·6	4·1	2·0
November	0·6	0·8	3·7	2·1
December	0·4	0·6	3·9	1·7
Total for the Year	21·5	26·7	39·7	20·8

It appears evident from the preceding table, that the greatest quantity of rain falls where there is the least evaporation; as in fact is certain, when the laws which have before been stated respecting the formation of vapour in the air are taken into account. It also appears that in months whose mean temperatures are nearly equal, viz., December and February, November and March, October and April, &c., there is nearly double the evaporation from water in the spring months, and nearly double the quantity of rain in the autumnal. It also appears that the quantity of rain in the west is nearly double that in the east; and the cloudiness of the atmosphere may be inferred to be pretty nearly in the same ratio, though not quite to so great an extent. It may also be inferred to follow partly the same law as the evaporation, but in an inverse order, and the mean state of the general cloudiness of the air may be between the two, and it may be properly considered to be about as three to two, or the cloudiness of the western part may be to the cloudiness of the eastern as three to two.

But it may be objected to this, that it is an indirect way of reasoning to show what might be directly proved by observation. In reply to this, I may remark that many persons have noted observations of the state of the atmosphere with respect to its cloudiness or clearness; but when the ever-changing and evanescent nature of clouds is considered—when it is also known that the same clouds assume such different appearances to observers at but a small distance from each other, so that a cloud that to one person may appear to obscure the whole heavens, may to another appear to hide but a very small part of it—observations will be seen to be subject to many disadvantages.

Again, during the night it is not to be expected that, unless for other purposes, observers will be found sufficiently numerous to determine the cloudiness of the sky with sufficient accuracy to be useful for the proper determination of the question. Yet a rude approximation may be come to by any one who carefully studies the subject; and so far as I personally have had opportunity of judging, the results I have given are quite in accordance with those arising from observation. Taking the whole of the British Islands, there is scarcely a day cloudless in the year; and, as far as I have been able to decide, I calculate that on an average fully one-third part of the heavens is always obscured by clouds; that on the west side of our islands three-fifths of the heavens are on an average clouded, and on the eastern four-fifteenths; but during the latter part of autumn and winter, on the western side one-half of the heavens is thus obscured, and on the eastern rather more than one-third. The preceding remarks apply more to England and Ireland than to Scotland, especially its northern parts. In many elevated places in the north of Scotland, the Orkney and Shetland islands, the sky is rarely clear, and the cloudiness is greater than in any other parts of the British Islands. The effect of the cloudiness of the atmosphere is to equalize the temperature of day and night; hence I showed, in stating the temperature of the different months at p. 626, that those least cloudy varied more than those having a greater quantity of vapour in the air. The reason of this is evident: the clouds prevent the radiation of heat from the earth. The experiments of Glaisher, as detailed in the Philosophical Transactions for 1847, have fully settled this point; but they not only prevent the radiation of heat by the earth during the night, they also prevent the access of the sun's rays to the earth during the day; and every one is familiar with the greater heat of the air when the sun *shines* than that when the sun is obscured by clouds. The cloudiness of our climate, then, has a great effect on its cultivation; for that cloudiness is unfavourable to the ripening of fruit and grain, but well adapted for the growth of grasses and plants of all descriptions cultivated for their fibre.

The direct rays of the summer sun tend to scorch up pastures, but to perfect the seeds of grain and the fruits of trees. The effect of the cloudiness of the sky on cultivation is more marked from being added to another of the same tendency. Thus, in places having an equal temperature, more rain falls where the air is the most cloudy and the evaporation least. Hence on the Continent they have not only less rain, but less clouds to protect the earth from the force of the sun's rays; therefore we see at once a reason for the perpetual verdure and the luxuriant growth of grass in our

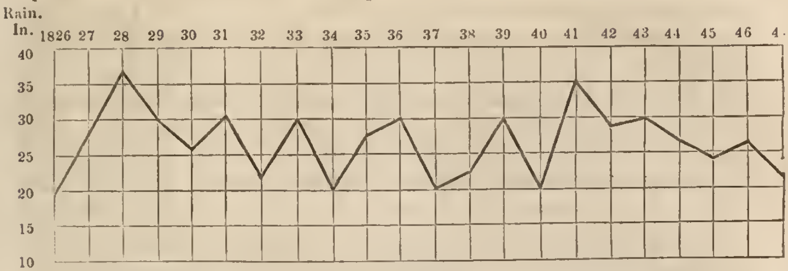
islands, and the comparative want of that verdure on the Continent. This also explains why fruit and seeds can be perfected there, which, with a similar average temperature, cannot be perfected in our islands.

The preceding subject also indicates that plants requiring regular and constant growth should be cultivated in the west and north; those requiring a high temperature for a limited period, should, on the contrary, be cultivated in the south and east.

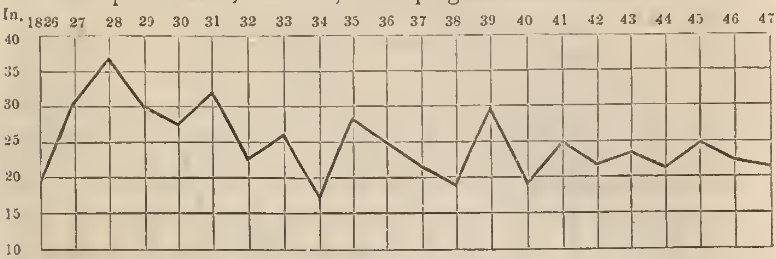
6th.—Different annual quantity of rain, and difference in the distribution of rain, with the signs of its approach.

To illustrate this subject graphically I have tabulated the fall of rain from the year 1826 till the year 1847. I have chosen the year 1826 for commencing, for I well recollect that year—it was the first year in which I had taken any active part in harvest operations, and hence, from having a considerable amount of curiosity respecting weather, &c., I have carefully observed seasons, and marked their effects, from that time to the present. Of course the whole of the tables do not, and could not be the result of my own observation. From private reasons I have every confidence in the accuracy of the results which appear annually in Moore's Almanack, having also had abundant opportunities of verifying their accuracy. I therefore give the results which have appeared there during the last twenty years, so that any one who may wish to test by close attention to facts the reasoning I adopt respecting the effects of climate on vegetation may have an opportunity of doing so. I have tabulated the results for three places; one in the east, viz., Epping in Essex, one in the midland counties, viz., Empingham in Rutlandshire, and one in the west, viz., Falmouth in Cornwall. The results show upon the whole a resemblance; yet it is evident from a mere inspection of the tables that the annual fall of rain is not always in the same proportion. I could have extended the tables, but found the labour greater than I had anticipated, and probably should have shrunk from that requisite to form the next, viz., the one for Epping divided into quarters, had it not been for its importance in future remarks. It appears from the following tables that the amount of annual rain may vary in particular seasons to the extent of half the average quantity either below or above the mean. Thus if any place have an average fall of 30 inches of rain, it may in wet seasons have rain to the amount of nearly 45 inches, or in dry ones have only about 15 inches. *It is very rare indeed that the variation is more than half of the average fall of rain.*

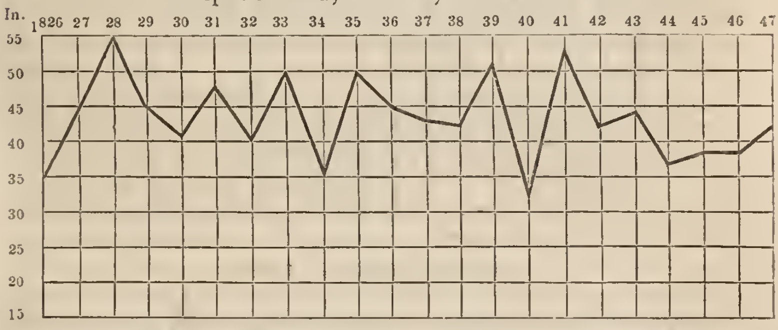
Depth of Rain, in inches, at Epping in Essex, from 1826 to the year 1847.



Depth of Rain, as above, at Empingham in Rutlandshire.

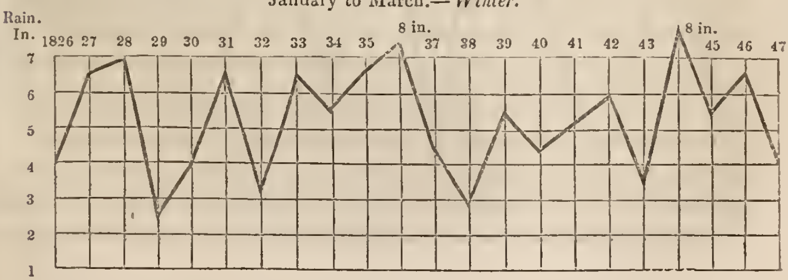


Depth of Rain, as above, at Falmouth.

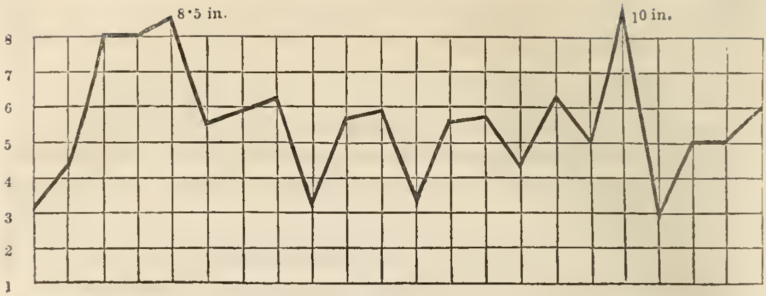


A Table of the Depth of Rain at Epping in Essex, during the four quarters of the year, for the same period, terming the first three months winter, the next three spring, &c.

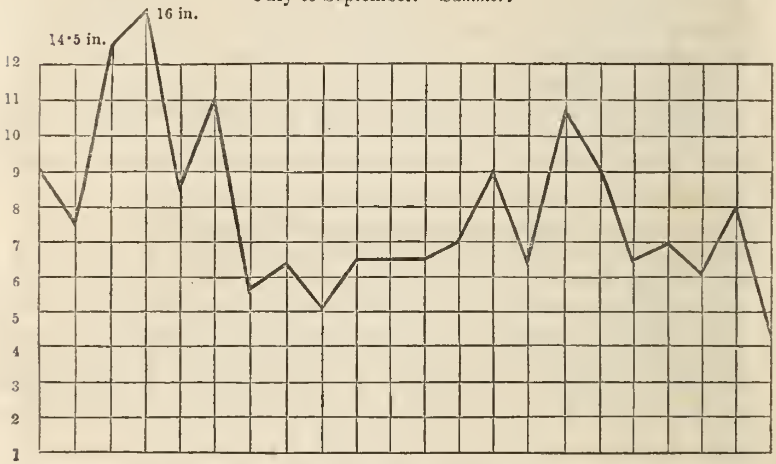
January to March.—*Winter.*



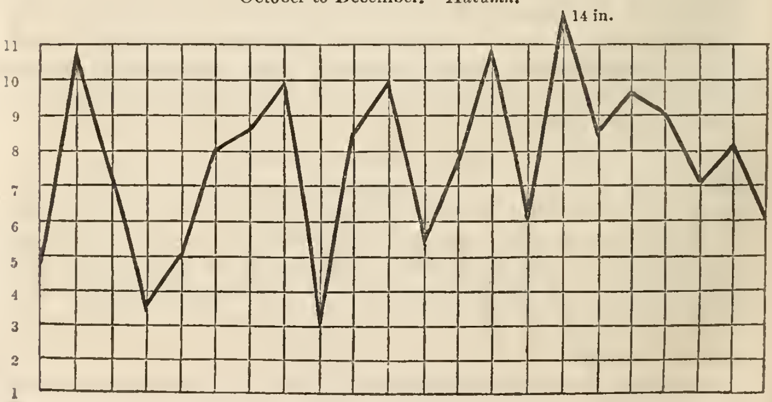
April to June. —*Spring.*



July to September.—*Summer.*



October to December.—*Autumn.*



The preceding tables will give a graphic idea of the annual distribution of rain during the year, and it will be seen that, as might have been expected, the greatest quantity of rain falls during months when the greatest quantity of moisture is in the air, or when the dew point is nearest the mean temperature of the air. Thus the rain of the last six months of the year is to that in the first six nearly as 3 to 2. The following is the average fall of rain taken during a great number of years at places situated in the British Islands:—

Places on the Eastern side.	Inches.	Places on the Middle.	Inches.	Places on the Western.	Inches.
London . . .	20·7	Chatsworth . .	27·6	Falmouth . .	42·8
Epping . . .	26·0	Empingham . .	25·1	Liverpool . .	34·4
Boston . . .	20·1	Retford . . .	24·0	Manchester . .	36·1
Edinburgh . .	22·2	Cambridge . .	25·0	Lancaster . .	39·7
Dundee . . .	21·6	Lincoln . . .	24·0	Kendal . . .	53·9
Aberdeen . . .	20·8			Dumfries . .	36·9
				Argyleshire . .	40·4
				Keswick . . .	62·4

From the above it is seen at once that the most rain falls in the west, but less on the western coast where sheltered by Ireland, as Liverpool and Manchester, whilst places higher than can be affected by Ireland again show an increase, as Kendal and Argyleshire.

In Ireland there fall on an average at Dublin 23·8 inches, at Cork 39·8 inches, and at Londonderry 30 inches.

I now come to a very important part of the subject, viz., the signs of the approach of rain.

It is generally considered that after the moisture of the air is condensed in the form of clouds, it is the withdrawal of electricity that causes the condensed vapour to form drops, and then by its specific gravity fall to the ground in rain. But it is quite certain that much that is spoken and written on the subject of electrical action is only another way of confessing ignorance, and after carefully considering the subject, I think that generally on the subject of rain it would be quite as philosophical to impute the discharge of electricity to the formation of rain, as to impute rain to the withdrawal of electricity. Cold condenses vapour into mist and clouds; as this condensation proceeds, water begins to fall, first slowly and in very minute particles, but as it continues to descend each drop increases in size by combining in its descent with the vapour in the air, and thus grows larger as it approaches the earth. Thus, though it rains oftener in high and mountainous countries than in low ones, yet if a rain-gauge be placed on the ground and another at some height in the air, the gauge on the

ground will have a greater quantity of rain in it than the one at a higher level. On elevated places the drops are small, and rain assumes the form generally of a drizzling haze. Every traveller on the mountains of the west of England, and in Scotland and Wales, is familiar with the fact, that there it is rarely quite fair, neither do the drops generally fall of a large size, but in a small fine haze, yet in descending into the valleys the drops are always felt to be sensibly larger.

Prognostications of the weather, especially with respect to the approach of rain, are generally formed from the barometer, winds, clouds, and the actions of animals, in addition to the opening and shutting of the leaves and flowers of plants; but with respect to the last, the signs of rain derived from the movements of plants are so near the weather they foretell, that they are generally of little use. Of all instruments used in foretelling the weather none is more general than the barometer; yet whilst many are inclined to trust entirely to its indications, others look upon it with contempt, and deem its indications of no use whatever. In the following remarks I shall endeavour to steer clear of both these extremes.

The barometer, as its name implies, is a measure of the weight of the atmosphere; and this indicated truly, is all it can do. If correctly made and graduated, if the index point to 30, it proves that a column of air, extending from its place to the limits of our atmosphere, is of equal weight to a column of mercury of the height of 30 inches—if it point to 29, that the column of air is equal in weight to a column of mercury 29 inches in height, &c. It is evident from this, that if one barometer be placed at the level of the sea, and another in a higher situation, their indications will be different, and therefore all persons living at any height above the level of the sea must make allowance for that difference. But when the weight of the atmosphere is ascertained, how is this to influence the fall of rain? This is an important subject, for it is certain that *directly* it has nothing to do with it, the atmosphere may be very light, and hence the barometer low, yet no rain fall; or the atmosphere very heavy, and hence the barometer very high, and yet rain may descend in torrents. This in our climate is especially so in March and February; also, in tropical regions, the barometer scarcely ever varies through the year, and yet at some times the rains are excessive, and at others the land is parched by continual drought. The reason why the barometer is there so uniform is because the winds are so unvarying; and the reason it here varies so much (the variation being in the British Islands about 3 inches of mercury) is because the winds are so changeable. The barometer then is most influenced by the wind, and is almost uniformly lower with a south or south-west wind than

with a north or north-east wind, and because a south or south-west wind coming after a north or north-east generally brings us rain, therefore rain commonly falls when the barometer sinks. I shall, before concluding, give the results of my own observation with respect to the indications of the barometer, and the best rules I can for forming an estimate of the state of the weather therefrom; but as rain depends for its production entirely on the moisture in the atmosphere, and its condensation there, it follows that, other things being equal, the most rain will fall when the air is most saturated with moisture. If then, instead of a barometer, an hygrometer were used,* they would know much better when rain might be expected; for with any means to determine the quantity of moisture in the air, and a barometer also, then when the air is nearly saturated with moisture and the barometer low at the same time, rain is sure to follow in a short time.

Winds.—From what was before stated under the article Moisture of the Air, it appears that the capacity of air for retaining moisture is increased by its heat; therefore if winds come from any place colder than our islands they will be heated in passing over, and therefore instead of causing rain will have a tendency to promote evaporation, and their effect will be to dry and cool places over which they pass: on the contrary, if winds come from places hotter than our islands, in passing over them their moisture, if they are near saturation, must be condensed and fall in rain; but if the moisture of the air be condensed and fall in rain on one side of our island, the rain may fall there in considerable quantities, and yet it may be dry on the opposite coast.

During autumn and winter then, when the temperature of the sea is higher than that of the land, an eastern wind will bring rain frequently to the eastern coast, but rarely to the midland or western counties. Again, the land being colder than the sea in a greater ratio during the night and till 10 A.M., the most rain will fall during that time, and that rain will generally cease and the day turn fine an hour or two before noon, and this I have observed to be the case in thousands of instances, the rain generally ceasing when the temperature of the land was raised to that of the sea. Thus, as might be inferred, eastern winds rarely cause rain at this season in the western counties, but the Atlantic being broad and the air crossing it having time to be fully saturated, and then being rapidly cooled in passing over the mountainous district of the western counties, the fall of rain is very great there, generally nearly double the quantity falling on the eastern coast, but as there is much more moisture brought by

* The best hygrometer is, I believe, the wet and dry bulb thermometer.—PH. P.

western winds so the extent of the rain is greater, only decreasing in quantity from west to east, whereas the eastern winds rarely bring rain to the western parts; hence the rains spreading over a large tract of country are most generally brought by winds coming from a westerly direction. This will be illustrated by the fact ascertained by the Royal Society, that no winds coming from between the west and north ever brought a day's rain at London in the course of the year, and that when it did rain for a short time the rain partook of the nature of haze, evidently coming from clouds very low, the air having previously lost great part of its moisture. They found that, near London, no rain of importance fell with the wind in any quarter from east to west in a northerly direction, but that when the wind changed from these quarters rain nearly always followed so soon as it arrived at any point from south-east to south-west. In the west and north of Scotland again the west winds often bring rain, which in Sutherland, Ross, and Argyleshire frequently continues for weeks together, but ceases when the wind changes to the south or south-east, and this change is generally succeeded by fair weather, especially in Sutherlandshire and Caithness. Some places, as high districts, which condense moisture from clouds which are too high to be affected by lower ground, and places nearly surrounded by sea, have rain with all kinds of winds; thus at Plymouth they have a rhyme somewhat of the following kind (I quote from memory):—

> "The south wind blows and brings wet weather,
> The north brings wet and cold together;
> The west wind comes and brings us rain,
> The east wind drives it back again."

The preceding remarks may make better understood the following signs of rain, which I have rarely known to fail:—

1st. If the wind change its direction from a district colder to one warmer than any particular place, at that place it will bring rain.

2nd. To places on the west of Britain, or in Ireland, if the wind change from the east or north to the south or west, rain is sure to follow in twenty-four hours

3rd. At places situated on the south of England or Ireland, if the wind change from a northerly to a southerly point, rain will certainly follow.

4th. To any place near the sea-coast, if during autumn the wind change from a land to a sea breeze, it will bring rain.

5th. Variable winds certainly bring rain; but generally only of short duration.

6th. If the hygrometer show the air to be nearly saturated with moisture, all the preceding results will follow more certainly, and with a greater amount of rain than would otherwise fall.

7th. The indications of the barometer are much more correct in summer than winter.

8th. If the barometer continue to fall in wet weather, then a continuance of rain may be expected.

9th. Pay little attention to the absolute height of the barometer, but to its changes; and if it has been very low and commences even to rise *rapidly*, it will probably rain in a few hours; but the rain will not generally be of long continuance. This is owing to cold air condensing the vapour, and at the same time adding to the weight of the air.

The signs of rain deduced from the clouds, are with respect to their changes into Nimbus, &c., known to all men used to the open air, so much better than I could express their changes in writing, that I pass them over. But the following results of experience I have found rarely to fail :—

1st. If the clouds move in the higher regions of the air in opposition to the wind at the surface of the earth, rain generally soon follows, in consequence of the mutual action of these contrary currents.

2nd. If on a foggy morning the higher regions of the air are also cloudy (which may be known by the particular blackness of the fog), rain is pretty sure in the course of the day—the air being unable to absorb the fog in the state of insensible moisture, in consequence of being already saturated in the higher regions.

3rd. A halo around the sun or moon (being caused by fine rain already falling in the upper regions) is sure to be followed by rain.

4th. If in hilly districts the fog, instead of clearing away, appears to roll along the sides of the hill, rain generally falls, commencing about an hour before noon, or from that time to 1 P.M. This in the northern parts of England I have observed for very many years, and scarcely ever known to fail.

5th. If the sky be bright and clear in the morning, and afterwards clouds begin to form near the horizon, rain is almost sure to take place during the day.

6th. If in the morning the clouds have a yellow or yellow and red tinge, rain is almost sure to take place during the day, for it shows that there is more vapour in the air than the sun's rays can easily penetrate, and hence any disturbance will cause it to be condensed.

7th. I may add, that there is a feeling about the air when charged with moisture, that many persons can easily detect even without the aid of an hygrometer, or any other instrument, and for many years I have been able to tell within a degree the difference between the dew point and the heat of the air. I have also met with many others who could do the same, and these per-

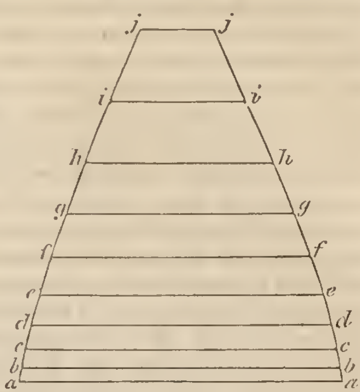
sons know almost intuitively that rain will follow certain states of the air; and upon the whole it will appear evident that almost all the rules that I have given, with many more that might be given, depend for their utility chiefly upon the degree of accuracy with which they indicate the amount of moisture in the air; and it seems on the whole better far to so determine it, than to infer it by less direct means. An hygrometer made by Leslie, or even the weather toy of the man and woman (contrived so that a piece of catgut shall pull out the man when contracted by moisture, or allow the woman to fall out by her own weight when not so contracted), will generally indicate the probabilities of rain pretty accurately. Moisture existing to a great extent in the air prevents the escape of volatile bodies upwards into the air, and hence causes flowers to smell more sweet, noisome scents to be more insupportable, fields of hay, beans, &c. to send forth a more fragrant perfume; whence also horses, cows, &c. snuff the air in their neighbourhood with delight. Moisture permeates all bodies, causes doors, windows, boxes, &c. to shut with more difficulty, spreads a damp along the brick floor of many a thrifty housewife, causes insects and worms to approach the surface of the ground; and who has not heard of scores of signs of rain that have been deduced from the above effects of moisture, in their varying forms? I knew well a good old woman who was deemed weatherwise in the village where she lived, and this character she owed entirely to judging by the dampness of her floor of the state of the weather.

In addition to the results before given respecting the quantity of rain, I may add, that from the mean of a great number of results, the number of rainy days on the east coast during the year is 135, and on the west coast 205, thus giving for the British Islands an average of half the days in the year as those on which rain or snow falls. Though *more* rain falls in summer than in winter, yet the *number* of rainy days is greater in the winter than in summer. The average number of days on which rain falls in the midland counties is, in January 13, February 12, March 11, April 11, May 10, June 9, July 12, August 13, September 14, October 15, November 18, December 17: the greatest quantity falling during the night, and the least from 12 A.M. to 5 P.M. of any other portion of the day.

8th. "Effect of elevation on temperature and lateness of harvest, with the highest level for the growth of corn in different latitudes."

In piling a large quantity of wool, if a great number of fleeces are laid one upon another, and these fleeces of equal size, it is evident that the lower fleeces, being pressed upon by those above, will occupy a smaller space. As they ascend, they will

gradually appear to increase in size, on account of the less pressure they bear; so that the spaces they occupy may be represented as follows, where the adjoining figure represents the pile, and the distances *a* to *b*, *b* to *c*, *c* to *d*, &c., the distances occupied by each layer of fleeces. It is also evident that the weight would be greatest upon the pile at *a a*, and decrease to nothing on the layer *j j*. Now, the same law that is so evident in the layers of wool, holds, but with much more accuracy, with the air. At the level of the sea it occupies a space which bears a pressure from the superior air equal to the weight of a column of mercury of 30 inches in height, or one of water of the height of nearly 33 feet. Now, supposing each layer of wool to have diffused through it an equal quantity of anything—say oil or water—then it is evident that this, like the wool, would exist in far greater proportion in the same space from *a* to *b*, than it would from *i* to *j*; and if a fleece were taken from the lower pile, and placed in the higher, the same moisture would then be spread over all the space from *i* to *j*, that had previously occupied the much smaller space from *a* to *b*. A similar result follows if a quantity of air—say a cubic foot—were taken from the surface of the earth, and liberated at the height of 14,000 to 15,000 feet—it would expand into double its volume; and the same heat that occupied only one foot on the surface of the earth, would occupy two feet at that elevation: and if the temperature had been 60° on the surface of the ground, that temperature would only be 30° at the height where it expanded into twice its volume. Again, if this foot of air was by mechanical means made to occupy only half a foot, the same heat would then give a temperature of 120°, and by this means—viz., forcing down a piston in a tube, and thus compressing the air—a match at the bottom of the tube may be set on fire.



This, then, may suffice to show the effect of elevation on temperature, but with respect to the lateness of harvest, &c., it requires a little more investigation.

At the equator, if we ascend a lofty mountain, we shall find every variety of vegetation; at its base the aromatic trees of the torrid zone; higher up, the sugar-cane and coffee-tree; still higher again, the olive and fig. Then the vines of France and

Italy, followed by the oaks, elms, &c. of England, succeeded by the pines of Scotland and Sweden, and then the lichens and mosses of Lapland, followed by the region of perpetual snow. Hence the journey from the base of a mountain to the height of 16,000 feet will be equivalent, with respect to its mean temperature, to a journey from the equator to the frigid zone. Yet there will be one great and characteristic difference—a difference, in fact, which makes a very important distinction in its vegetable culture. In ascending the mountain we have a gradual decrease of temperature, and this is uniform through the year. Thus, at the equator, allowing the temperature to be 81·5°, in going to the height of 252 feet the temperature will be 80·5°. In ascending 253 feet higher, 79·5°, and so on; this temperature being uniform during the whole year. On the contrary, and this distinction is important in its effect on the growth of corn, in going from the equator to the poles the same decrease of mean temperature takes place as in ascending a mountain, but this is caused by the *cold of winter increasing nearly twice as rapidly* and the heat of summer decreasing in only a *small* degree. Thus Moscow has a degree of heat in summer only 12° inferior to that of the equator, whilst the cold of winter is greater by 70° than the mean of the same line. On this account, those kinds of corn requiring but a short time to arrive at maturity and perfect their seed may grow near to the pole during the summer, and we accordingly find barley growing as far north as 70° of latitude in Lapland. Thus, the sun being above the horizon at the pole for six months in the year, it has been calculated by eminent mathematicians that the heat of summer at the poles ought to be greater than at the equator, they considering that the length of time the sun is above the horizon there ought to make up for the obliquity of his rays. But though this is not the case, yet, when the rays of the sun are allowed their full effect, they have been known to set fire to forests in Norway and Sweden, and during Sir John Franklin's expedition the heat was sufficient to melt the pitch from the ships in latitude 67°. On this account it is then, that where places have a southern aspect corn can be ripened though the mean temperature of the year be below the freezing point, or farther north than the isothermal line of 32°, which passes from Ulea, in Lapland, latitude 66°, to Table Bay, in Labrador, latitude 54°. But it must by no means be inferred from this that corn will grow on elevated situations whose mean temperature is so low; on the contrary, in the plains of Quito corn will not ripen in places having a mean temperature of 55°, or one equal to that of France. Again, the olive, fig, myrtle, vine, and mulberry will grow to the size of the oak in mountainous situations in the tropics whose mean temperature is less than

that of England. Yet though in these situations they vegetate with a luxuriance unknown in Spain or Italy, yet they never produce fruit, even in places whose mean temperature is higher than that of Italy, and you would look in vain to these apparently luxuriant trees for that fruit they cannot produce without a summer temperature higher than they can there attain.

Effect of Climate on the Growth of Grass.—I shall, in writing on this subject, include under the popular term Grass all the different species commonly cultivated for their leaves and stems, not including those particular cases where they are cultivated for their seeds.

Grass vegetates with the air at any temperature above the freezing point and the ground at a temperature varying from 40° to 36°, and any temperature less than this prevents its growth entirely. On the other hand, unless there be a great quantity of moisture in the air it will scarcely vegetate with a degree of heat greater than 66°, unless the ground be moistened naturally or artificially. It will vegetate best with the air on the point of saturation; hence on a porous subsoil and in a dry atmosphere the pastures are during summer burnt up by drought. From many careful observations made in our own country as to quantities of stock kept, and length of grass in different seasons, as well as by the accounts given by Humboldt, &c., I have come to the following conclusions respecting the influence of climate on the growth of grasses generally:—

1st. That the growth of grass is always proportionate to the heat of the air, if a sufficiency of moisture be present in the atmosphere.

2nd. That in our climate the moisture present is rarely sufficient to allow the temperature to have full effect when the temperature exceeds 56°, but if moisture be artificially supplied, as by irrigation, to catch-water meadows, then vegetation will still proceed in proportion to the heat.

3rd. That when the temperature of the air is between 36° and 41°, grass will only vegetate with a fifth part of the force that it will when the temperature is 56°. Thus land that will keep ten sheep per acre in the latter case, will only keep two in the former. That from 41° to 46° its growth is two-fifths or double that of its growth when the temperature is under 41°, and it will then keep four sheep instead of two. Again, from 46° of temperature to 50° its growth will rise to seven-tenths, or it will keep on the same ground from five to seven sheep; and from 50° to 56° it generally, unless assisted by an artificial addition of moisture, arrives at its maximum, but if the month of June be very moist, it will continue to grow with an increase of force up to 60°. Hence generally grass with the same temperature grows

fastest in wet and moist weather, and hence grows fastest during September and October, in proportion to their temperature, on account of the greater moisture of these months.

4th. The above remarks apply to the cereals as well as the other grasses whilst the sap is in a vigorous and rapidly circulatory state, as it is in most plants before they begin to form their seed.

From what has been before said on the distribution of heat, moisture, &c. in the British Islands, it is evident that all the conditions of the atmosphere favourable to the growth of grass are fulfilled in Ireland and the western parts of England, also generally through the whole of Scotland, and that elevated places too high for the growth of corn and too wild to produce naturally any valuable produce might by being brought into cultivation be made to produce abundance of green food for cattle, and the produce, other things being equal, may be easily calculated; for in elevated places moisture sufficient for the growth of grass is always present, so that by applying the remarks I have made to the temperature of the several months of the year, any person may calculate the value of the produce of land thus elevated, as compared with land situated on the level of the sea. That the universal experience of agriculturists points out Ireland and the western parts of Britain as best suited for the growth of grass is so well known, that it would be out of place to attempt any proof of the fact.

The Effect of Climate on the Cultivation of the different kinds of Grain.—It is certain that wheat is an exotic plant, and its cultivation artificial. Thus it differs from the natural grasses, and it requires in the British Islands more care in its cultivation than it does in places more naturally fitted for its culture. Wheat requires for its successful cultivation to the best advantage a temperature of 54° during the year, and for two months during the year a temperature of 68°. This, except in very rare years, is never fulfilled in the British Islands; therefore wheat can never be cultivated here to the same advantage as it can in a warmer climate. A continental climate too is more favourable to the cultivation of wheat than an insular one, wheat requiring a greater summer heat for the perfection of its seed than any other of the cereal grasses. Wheat will not begin to flower with a less temperature than 57°, and the less moisture in the air and the less rain falls from that time to harvest the better for the crop.

Hence the warmest and driest seasons are the most favourable to the yield of wheat. This obviously indicates the places most advantageous for its growth in the British Islands, the south and eastern parts, or those having the greatest summer heat; and experience has fully borne out this, for comparatively small quan-

tities of wheat are grown in Ireland or the western counties of England, and what is grown there is of inferior quality; hence in comparing the prices of wheat it is always found that the south and eastern counties are quoted as the highest, generally from 2*s*. to 3*s* per quarter above the north and midland counties, and 3*s*. to 4*s*. higher than that grown in the eastern parts of Ireland. But though wheat requires heat and dryness to ripen and perfect its seed, yet being one of the grasses, it requires for the development of its stalk, &c., moisture and warmth during its growth as a grass, and its fibre will be deficient unless the season be favourable from April to June. This was illustrated in 1846, the straw that year being generally light; and in that year the south-eastern parts of Britain had rather light crops, though abundant yield for the quantity of straw, and, contrary to the regular course of things, wheat in the midland counties excelled the wheat of the south and eastern counties; and in the neighbourhood of Dublin that year the crops of wheat were splendid. In fact, never were the wheat crops better in moist situations than in 1846. With respect to the effects of elevation in retarding harvest I was early led to think. My grandfather, uncle, and father, each had large farms in Yorkshire; and that of my grandfather was nearly at the level of the sea, that of my father at an elevation of 200 feet to 300 feet, and that of my uncle at an elevation of 450 feet to 500 feet, but on the limestone of the oolite formation, whilst my father's and grandfather's were on a strong loam formed by the blue lias. My grandfather and the neighbourhood at the same level were invariably a week earlier than my father in commencing their harvest; whilst my father always was a week earlier than my uncle. Since then I have made frequent observations which have caused me to conclude that, *cæteris paribus*, harvest (wheat harvest especially) is delayed a week by every 300 feet of ascent. The observations on which the above opinion is founded have been made in most of the northern, eastern, and midland counties. I have found the delay not so great on the Yorkshire and Lincolnshire wolds, but about a week along the range of hills formed by the oolite, and rather more on the hills formed by the old red-sandstone and magnesian limestone, the average being stated above for the whole. These remarks, of course, refer to table-land. On the sloping sides of hills nearly all depends on their inclination being to the north or south, &c., as will be evident from the figure at p. 622. Wheat, to arrive at maturity, must have an average temperature for two months (or from its commencement to flower till its seed be matured) greater than 57°; and taking the average of seasons in the British Islands this condition will not be fulfilled at an elevation greater than 700 feet in the south,

and descending to the level of the sea in the counties of Inverness and Aberdeen, in Scotland. In summers like 1826 and 1846 this may extend to 850 feet in the south, and at the level of the sea to Sutherland; and in bad seasons, as 1841, be limited in the south to 400 feet above the level of the sea, and at that level to the counties of Fife and Stirling, in Scotland. It will be readily seen from what has been stated, especially with the present prospects of farmers, that I would not advise the growth of wheat at any high level; and if from the middle of Great Britain northwards any place be elevated 200 feet above the level of the sea, unless the slope be favourable, crops of far greater safety and profit may be cultivated than wheat in such a situation. When it is necessary to grow wheat towards the limit of its growth, either in elevation or latitude, salt should always be used as part of the manure. This my father has proved, during a long course of years, to cause it to *ripen on an average fully a week before wheat in the manure for which salt had formed no part.*

Barley, like wheat, is a native of a warmer climate than that of the British Islands, and is affected by difference of climate in a similar manner with wheat. It succeeds best in the same spots as wheat with respect to climate, only requiring different soil. In places where the climate is favourable it will yield two crops during the year, as in Spain and Italy. It can be perfected in the short space of ninety days; hence some have argued erroneously respecting it, and have accounted it a hardy grain, as it will grow in Lapland as far north as 70°. But from what I have previously stated as to the heat of summer in places having a high latitude, it will be found to owe its cultivation there not to its hardihood, but to the short period required for its growth, the heat of that period being in Lapland often greater than it is at the same time in some parts of Scotland, It will not generally perfect its seed below a temperature of 56°, but, according to Humboldt, will succeed wherever the temperature of three months exceeds 48½°. The south and south-eastern parts of our island are the best fitted for its growth; and Norfolk barley has been long famed for its excellence. Barley is very tender, and is frequently destroyed by the blasting fogs which occur during the autumn in Scotland, whilst oats and other grain are comparatively uninjured. It requires much silica in the soil when it is cultivated; and a deficiency of this ingredient in the soil, or a moist season, cause it to grow with a stalk too tender to support itself, and as the ear fills it falls to the ground, and is comparatively valueless. The height to which it may be cultivated with success in our islands extends from 1000 feet in the south to 800 feet in the south-east of Scotland and 600 feet in the south-west, and approaches near to the level of the sea in the north of the

same country. It is retarded by elevation in coming to maturity in the same proportion as wheat, and could not be cultivated at a higher level than wheat but for the short period of its growth.

Oats are quite opposed, as to the effect of climate, to the two preceding kinds of grain. Oats are native to our climate; hence they grow wild, and are frequently difficult to eradicate. Now, any plant growing wild must, from the very nature of things, always be easier to cultivate than an exotic. They differ, too, from barley and wheat, in requiring a humid climate. Thus whilst barley is cultivated extensively in Asia and the eastern parts of Europe, oats are unknown there. The Mongol feeds his horses and himself often on barley, but is unacquainted with the cultivation of oats; and we have thus on a grand scale the development of what is witnessed in our islands. Barley, as if seeking a more genial climate, succeeds best in the eastern parts of our islands, and requires much care even there. Oats having on account of the general humidity of our climate a favourable situation throughout its whole extent, yet prefer the western and most humid parts thereof. As illustrative of the above, it was found by Lord Clarendon in 1847 that out of 3,313,579 acres in Ireland under corn culture, 2,200,870 acres were oats; twice as many acres as of all the other kinds of grain together.*

Oats will succeed at a much greater elevation above the sea in our climate than barley, and therefore in reckoning on elevations suitable the line may be made to extend from 200 feet to 250 feet higher than the preceding which I have given for barley. Hence in the hills of Yorkshire and Lancashire I have frequently seen oats at the height of 1150 feet, and in Scotland oats are cultivated at the height of 900 feet to 1000 feet in the lead-hills of Lanarkshire, and in the slope of the Pentland Hills in Mid-Lothian. Oats, on account of the comparative small quantity of inorganic matter they contain (only about one-third of that of wheat),† are particularly suited for peaty and other soils

* Notwithstanding the deficient agriculture generally in Ireland, Mr. M'Culloch gives the average of oats at 5 quarters per acre in Ireland, the same as in England and Scotland; whilst he gives the average of wheat in England 4 quarters, in Scotland 3½ quarters, and in Ireland at 3 quarters. Of Barley Mr. M'Culloch gives the average produce in England 4 quarters 2 bushels, in Scotland 4 quarters, and in Ireland only 3½ quarters. And whilst there are in England 3,600,000 acres of wheat and 1,500,000 of barley, in Scotland there are of wheat 350,000 acres and of barley 450,000. In Ireland, of wheat 450,000 acres and barley 400,000. From the preceding, it appears that in Ireland oats afford an equal crop to what they do in England; whilst wheat and barley are estimated to yield nearly one-third more in England than in Ireland, showing that, as to oats, the favourable climate in Ireland makes up for deficient cultivation. It appears also from the Parliamentary Papers for 1849, that during the dry years of 1826 and 1827 there were twice as many oats imported into England as wheat in 1826, and five times as many in 1827; whilst in the wet years of 1828 and 1829 there was imported into the United Kingdom nearly four times as many quarters of wheat as oats, thus showing in a striking manner the favourable effect of moisture upon oats, and of dryness upon wheat.

† Liebig on Agricultural Chemistry, p. 143.

abounding in organic matter; and there are few of those extensive bogs under the height of 1200 feet along our western shore but what might be made, if drained, to grow oats *to the extent of eight to ten quarters per acre, and, under a rotation of oats, potatoes, oats, seeds, §c., amply pay the expenses incurred by reclaiming them.*

Oats will ripen their seed where the mean temperature of two months in the summer rises to 50°, but they require the heat of the day to rise to 66°.

Leguminous Plants, Beans, Peas, §c.—The effect of climate on the growth of the above plants is a combination of that on wheat and oats, beans, peas, &c., requiring the warmth suitable for wheat, and the moisture suitable for oats; hence warm and moist years are most favourable for their growth, and in the warm and moist year of 1828 the extra crop of these grains reduced the average price from 47*s.* 7*d.* per quarter in 1827 to 36*s.* 8*d.* in 1829, whilst at the same time wheat had risen from 56*s.* 9*d.* to 66*s.* 3*d.* during the same time. Beans and peas will bear the late frosts better than any of the other kinds of grain, and generally flower the first of the corn crops. They yet require a comparatively high temperature to perfect their seed, and hence will not succeed well where the average temperature is too low for the cultivation of wheat, neither will they grow at a greater elevation, though as green food they may be grown in any place suitable for artificial grasses. Experience has determined that the southern parts of England and Ireland are most suitable for beans, and the climate seems to favour their culture at the level of the sea as far as 56° 20′ of north latitude, to a line from east to west, cutting Stirling and Dumbarton at their northern extremities. They require a soil to be strong loam and similar to that for wheat, but as they require more moisture they succeed better in the midland than the eastern counties. Hence Dorsetshire, Hampshire, Buckinghamshire, &c., are the most suitable for the successful growth of the above plants. I am not in possession of a sufficiency of data to determine the temperature requisite to perfect the seed of the above plants, but am convinced by many experiments they will not flower under a temperature of 52°, and am inclined to think that they require a temperature little short of that of wheat to perfect their seed.

Of plants cultivated for their roots, potatoes and turnips are the most important, and they are evidently both naturalized in our climate, the former suiting it so well that two crops may sometimes be cultivated in one year (a sufficient proof that we have a wide range of temperature to accommodate the peculiarities of their growth); and the latter having their type growing wild as the most inextinguishable of our weeds in the wild charlock.

Potatoes will vegetate whenever the temperature of the ground

rises to 40°, and will perfect their seed as late in the season as the ground retains a temperature of 45°; if not ripe before the temperature falls below this, they remain unripe, and will wither if kept, though they may of course be eaten when they are fresh dug even in that case. Heat and moisture increase their power of vegetation, hence in the moist and warm year of 1828 there was the most splendid crop of potatoes in the British Islands that has been known for a century. A humid climate and a soil abounding in organic matter are circumstances particularly favouring their growth, and they are thus similar to oats; they exhaust strong clayey soils, but flourish on, without appearing to injure, light and peaty soils. They also appear to delight in saline matter, and it is found by experience that they succeed best in Ireland, Scotland, and the western parts of England, Lancashire and Cheshire being the English counties where they are most successfully cultivated. Potatoes commonly fail, if at all, in consequence of the dryness of June and July, and therefore early planting is best for them.

The culture of turnips is in our islands highly artificial. In a state of nature turnips would (if sown) in our climate spring up in February, flower in May or beginning of June, and ripen their seed in July or August. But it was found that turnips possessed the valuable property in our climate of being arrested in their progress, and that after the formation of their root and its perfection, the cold of winter would, by checking their growth, prevent their tendency to perfect their seed, and maintain them in this state till the rise of the temperature in the spring was sufficient to allow their progress. The great purpose therefore for which the turnip is cultivated is to supply food for cattle during winter. But as the value of turnips as food is only great before they begin to raise up a stalk for the purpose of perfecting their seed, and they being for the purpose of food of the most value just at the time when they begin to rise into stalk, the great purpose to be accomplished is to arrest their progress just at the critical time—if arrested sooner they not coming to their full size; and if permitted to grow longer, part of the root being converted into woody fibres. Turnips will vegetate at all temperatures above 40°; when the temperature sinks below that they cease to grow, therefore by sowing them in time for them to attain their full size before the temperature sinks below 40°, and yet not so early as to allow them time to run to seed, their growth will be checked, and they may be kept in perfection till the temperature again rises above that height. The season when the effect of our climate checks the growth of the turnip plant is generally November, and the time when the temperature rises sufficiently high to again allow of their growth is the early part of March, but in Scotland this rise of temperature does not com-

monly take place till the commencement of April. According to the slowness or rapidity of the growth of the different kinds of turnips they are found to arrive at maturity at the proper time when sown at different seasons from the middle of May to the early part of July. The effect of climate on the cultivation of turnips then is readily acknowledged; where the winter temperature, or at least the temperature of some month in the year, does not fall below 41°, the growth of turnips cannot by the climate of that place be checked, therefore the turnips must be consumed when they arrive at maturity, taken from the ground, or allowed to run to seed. But as turnips when taken from the ground in warm climates soon lose their freshness, and at the same time grass and other food can be grown at all seasons, it becomes evident that turnips will in such places only be cultivated for consumption when they arrive at their full growth, and will not be grown for the purpose of being preserved. On the contrary, where the winters are severe, and at the same time the summer temperature favours their growth, *there* they must be of immense importance, for there no other plant will grow in the same space of time so large a quantity of food with so little labour and so easy of preservation, the climate itself arresting its growth at the proper time, and thus preventing the trouble of reaping and storing. From the above we see one reason why the cultivation of the turnip is in good husbandry so essential a feature in Scotland and the eastern parts of England, and so comparatively unknown in Ireland and the south-west of England. In the former situation their excellence as a substitute granted by Providence for the natural grasses that could not be produced in winter in sufficient abundance must be evident, whilst the same temperature that prevented the growth of grass is the means of preserving the turnips in a proper state for food. On the contrary, all places situated south-west of the line of 41° winter cold, have a natural provision of winter food in the growth of the grasses, whilst the same mildness of temperature that allows the growth of grass would also allow turnips to run to seed, if permitted to remain after they had attained their full growth, and consequently compel their consumption or removal from the land. Thus, whilst the necessity for their growth is not so great, their value when grown is also less, consequently a point must arrive when their cultivation will cease to be a part of good husbandry

It is the province of others to point out to what extent they should be cultivated for consumption or storing under these circumstances, and to show, from the quantity of food turnips can produce in a given time, as compared with other descriptions, whether or no they should be preferred; it seems sufficient here to show that turnips are affected by climate in the preceding different ways, according to the temperature. But from the

manner in which turnips are raised being highly artificial, their culture requires as practised much care: were they sown in February, and allowed to come to maturity in June, the crop would be certain, and there would be no more danger of its failure than of the failure of a crop of oats; but being sown when the weather is often dry and the temperature high, the moisture so essential to the progress of the plant is very commonly deficient. On this account dry and hot summers are very unfavourable for the growth of turnips, and the farmer who sees in June and July the weather suitable for his wheat crops, very commonly sees at the same time that the same weather is preventing the progress of his turnips. Scotland is more favourable to the growth of the turnip than any other part, where it is extensively cultivated, owing to the greater moisture and less heat of the climate during the period of their early growth. Rape, though much resembling turnips in cultivation, *seems still better fitted for cultivation in the western parts of England and Ireland, as in these places it may be preserved and eaten either in winter or during the spring months.*

I now proceed to the last topic, and inquire "how far it is desirable to adopt the regular four-course arable system on the western sides of England and Ireland, the same being naturally fitted for the spontaneous growth of grass."

This is naturally a subject on which difference of opinion must to a great extent exist, and it would ill become any person dogmatically to settle the point as to how far it is desirable to adopt any system of so general and important a nature as the one in question. Yet it may be useful to point out a few of the more important principles of such a plan, and the advantages and disadvantages may probably be thus more easily calculated and applied to any particular case. It seems evident from what I have stated in the preceding pages, that these places are ill-adapted for the growth in perfection of wheat or barley; and also that the extreme south-western parts are not favourable to the growth of turnips for winter consumption, unless intended for consumption on their arrival at maturity; for it is well known that no root impoverishes the land so much as turnips if allowed to run to seed, and nothing injures the turnip so much as allowing it to run even to stalk, the nutritious part of the turnip being absorbed by the growing stalk. Now wheat, turnips, and barley are, as it is well known, generally considered a *sine qua non* in any *regular* four-course system; and I think that farmer must have great confidence who in the present aspect of affairs would wish to attempt the cultivation of wheat or barley at any considerable elevation in places so naturally unfitted for them, and thus have to contend with parties favoured by a climate more propitious.*

* Since writing the text, I was glad to see, on receipt of the 'Royal Agricultural Society Journal,' an article on "Water-Meadows," &c., by Mr. Pusey, in which the

Yet there may be exceptions to any general rule, and places having a sunny slope, a dry and porous subsoil, and a sandy soil, may grow barley of an excellent quality for the feeding of cattle, though it can never be so valuable for malting, as when it is grown in more eastern situations. Taking into consideration all circumstances, I do think that where grass can be grown to the extent of feeding an ox during summer and 2 sheep during winter, or of keeping 8 sheep during the summer and 2 during winter, that grass land should not be broken up, especially as grass land of a good quality continues to improve, and if once broken up is rarely restored to its former quality; and in no part of England have I ever known that the breaking up of grass land when the soil was very tenacious, answered the expectation of those persons who broke it up. On the contrary, many parts of England (particularly the large vale of Cleveland, in Yorkshire) have been reduced to half their original value by being converted from pasture to arable land. It is well known that land laid down to grass and properly attended to, goes on improving in value every year. But let this land be broken up, a few luxuriant crops of corn may be grown, and under the idea that the expense of its conversion into arable land must be repaid, exhausting crops frequently succeed each other, the organic matter is exhausted, the clay again brought to the surface, and in a few years the land is so far exhausted as rarely, even with skilful management, to repay the expense of its cultivation. But when this is discovered, and it is again wished to lay this land down to grass, it is found that no plan now known is able to restore it till the lapse of many years to its original value as grass. Grass then on clay soils, if affording a good natural herbage, should not be thus changed from pasture to arable land in any situation; but particularly on the western sides of our islands. On sandy and light soils a natural herbage is sooner formed; but in no case, even in situations and soils best fitted for the spontaneous growth of

effects of irrigation are stated and illustrated by their practical effects. In that paper Mr. Pusey states, that on grass land of moderate quality he has kept at the rate of thirty-six sheep for five months on one acre of land. The sheep were folded as on turnips, and, as every practical man knows, it is a good crop of turnips that will keep twelve sheep for five months. Thus by a cost of *4l.* to *5l.* per acre the produce of grass land can be made much superior to any result obtained by the growth of root crops, especially when the climate is so favourable to grass, and not well suited for turnips. This, then, is evidently the way to produce food on the western parts of England and Ireland. The climate of England and Scotland being so fitted for the growth of grass, and so diversified by hills, valleys, &c., as to be well suited for irrigation on the western side, and the large quantity of rain falling there also being in favour of this method, I sincerely hope that the paper of Mr. Pusey may turn the attention of the residents in our western counties to the subject, and that thus they may follow out an excellent plan every way suited to their climate, rather than attempt to follow a method of agriculture which, though well fitted for our eastern, is not at all adapted for our western counties. By this the mildness of winter will be turned to good account, and the moss destroyed which so greatly injures the present pastures.

grass, can a good pasture be formed in the course of four years. No matter what kind of grass-seeds are sown, whether natural or artificial, sooner or later a transition period arrives, when the seeds sown are partially succeeded by other kinds which spring up spontaneously, and the transition period is always one of deficient pasturage. One or two years the pasturage may be good, it then deteriorates, with greater or less rapidity, and then begins again to improve, and goes on improving for often an indefinite time; probably, in lands of a very tenacious kind, that improvement may go on for centuries. The preceding remarks tend to show that the worst possible way of treating land is to exhaust it by arable culture, and then lay it down for three or four years to recruit or rest, for by this plan the pasturage after the first or second year is comparatively worthless if sown with the best seeds, and still worse in the common mode of management by the followers of this method. When grass land in its natural state does not keep at least 6 sheep or 1 beast per acre during the summer, it is certainly wastefully employed; but the proper way to prevent this, in my opinion, is not to attempt the growth of wheat or barley, but to convert the pastures into arable land, and adopt not a regular, but an irregular course, and one fitted for the western sides of our islands; and the principal point for consideration should be the growth of green food for cattle, and in connexion therewith the growth of oats, flax, potatoes, &c. By a skilful arrangement of these crops, for which the climate is excellently adapted, a rotation equally profitable with the regular 4-course system might easily be followed; for instance, a course of the following kind:—1st year, oats, succeeded by winter vetches; 2nd year, potatoes, and succeeded by rape; 3rd year, oats with seeds; 4th year, seeds for pasture; 5th year, beans; 6th year, flax, pulled for white line, and succeeded by winter turnips; and this might be varied various ways, and perhaps two crops might be grown every year, when the mildness of the winters on the western side of our islands is taken into the account.

As I stated previously, the breaking up of grass lands is a subject much controverted, and after all resolves itself into a matter of pounds, shillings, and pence, for that is always most profitable for the nation that is permanently so to individuals. The great end to be kept in view is to take advantage of the mildness of the winters and the humidity of the climate on our western coasts by the cultivation of such crops as these are friendly to. Now, mildness of winter is of no use to plants and crops which only require for their cultivation the period of summer; therefore if only these crops are cultivated, the power of production during winter being unemployed beneficially, will be positively injurious, and tend only to the fostering of weeds. Land thus treated then is evidently not employed in the most advantageous manner,

and can only be so employed by cultivating thereon plants which at the same time that they yield food for cattle during summer, will also either themselves vegetate during the winter, or be reaped in time for the cultivation in the same year of other plants capable of doing so.

Finally, we may learn to regard with *caution*, and judge with *charity* methods of agriculture that may be different from our own; with *caution*, because, however excellent in one situation, they might not suit the climate of our own farm—with *charity*, because though a plan may have been found to fail with us, it may be admirably suited to other and different situations. Especially should parties residing at a distance from each other, as in Scotland and the south of England, *avoid either rashly censuring or blindly following each other's methods;* and all experiments with respect to tillage, cropping, manures, &c., that when published they may be of general utility, should be accompanied by some account of the aspect, nature of soil and subsoil, inclination of the surface, &c. of the field or farm where the experiments have been tried. In the hope that the preceding pages may have the effect of leading the farmers of our islands to think of the effects of climate, and through *observation guided by science* induce them to coincide with, not oppose, its indications by their practice, I now bring these remarks to a close.

Saxilby, Lincoln, January 29, 1850.

APPENDIX.

Containing the Depths of Rain, from Moore's Almanac, at different Places from 1829 to 1847, and referred to at p. 638.

Depth of Rain in 1829–1832.

Month.	Year 1829.		Year 1830.		Year 1831.		Year 1832.	
	Epping	High Wycombe.	Epping.	Boston.	Bedford.	Epping.	Epping.	Kendal.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	·698	1·081	1·83	1·65	1·327	1·775	1·040	2·278
February	1·182	1·419	1·69	1·66	2·592	2·634	·361	4·258
March .	·458	·575	·53	·12	2·662	2·174	1·529	3·549
April .	4·862	4·456	2·25	2·63	1·167	1·549	·746	2·235
May . .	·595	·506	2·67	4·01	1·553	1·511	1·872	1·602
June . .	2·676	3·6	3·58	3·95	3·62	2·467	3·244	4·643
July . .	4·957	4·763	1·48	2·02	3·203	3·041	·872	2·639
August .	6·827	4·681	3·35	2·33	3·816	2·73	3·993	4·433
September	4·228	4·481	3·75	4·20	4·458	5·197	·852	2·295
October .	2·079	2·038	·65	·64	4·950	3·637	3.755	8·346
November	1·127	1·55	3·16	1·34	4·312	1·637	1·955	5·373
December	·351	·331	1·3	1·35	4·788	2·575	2·452	8·037
Total .	30·140	..	26·24	25·90	37·848	30·927	22·671	49·788

Depth of Rain in 1833.

	Ackworth.	Bedford.	Boston.	Chiswick.	Epping.	Penzance.	Wycombe.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	·76	·881	·61	·52	·623	3·725	·87
February .	2·76	4·933	4·51	3·98	5·062	9·73	5·68
March . .	1·34	·331	2·26	1·22	1·028	5·655	1·28
April . .	2·78	1·88	2·3	2·71	2·544	3·315	2·58
May . .	·51	·418	·53	·68	·853	·8	·38
June . .	3·11	2·042	3·17	2·63	2·788	5·6	2·62
July . .	1·09	1·599	·6	1·46	2·306	1·81	1·88
August .	4·5	3·388	2·02	1·93	3·285	1·135	2·2
September .	1·49	1·26	1·49	1·55	1·439	4·305	1·89
October .	2·76	1·826	2·23	2·37	2·13	3·765	2·81
November .	1·32	1·508	·86	2·38	2·312	4·665	2·48
December .	2·61	1·926	1·98	4·29	4·857	7·78	4·9
Total .	25·06	21·992	22·62	25·72	29·227	52·285	29·57

Depth of Rain in 1834.

	Ackworth.	Bedford.	Boston.	Chiswick.	Epping.	Stratford.	Thurston.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	3·7	2·589	2·41	2·87	4·521	2·72	2·627
February .	·57	·512	·45	·37	·7	·45	·432
March . .	1·49	·341	·36	·86	·594	·66	·54
April . .	1·83	·709	·64	·65	·466	·65	·702
May . .	·66	·805	·81	1·19	1·036	·86	·54
June . .	1·99	·821	1·36	1·63	1·674	1·65	1·215
July . .	7·03	2·032	3·84	6·34	4·294	5·83	3·545
August .	2·09	1·482	1·39	2·73	2·439	3·56	1·555
September .	1·83	3·115	1·3	·83	1·118	·59	1·195
October .	·26	1·148	·67	·43	·383	·61	·86
November .	1·16	1·71	·79	1·75	1·782	1·52	1·34
December .	1·13	·512	·64	·74	·864	·59	·85
Total .	23·74	15·776	14·66	20·39	19·871	19·69	15·401

Depth of Rain in 1835.

	Ackworth.	Bedford.	Boston.	Chiswick.	Epping.	Kendal.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January . .	1·77	1·148	1·72	·72	1·017	5 349
February .	2·69	2·703	2·	2·61	2·896	8·82
March . .	1·67	2·875	2·68	1·97	2·74	5·049
April . .	1·06	1·667	1·79	1·06	1·886	1·589
May . .	2·6	5·173	2·1	3·38	1·523	3·063
June . .	2·28	2·616	2·04	1·99	2·139	1·254
July . .	·63	·945	1·2	·41	·516	6·259
August . .	1·55	·471	·84	·18	·929	3·107
September .	2·33	4·159	2·61	4·6	4·78	7·815
October .	2·47	4·223	3·58	4·05	5·61	4·386
November .	2·02	2·383	1·74	1·94	2·297	6·311
December .	·12	·295	·27	·25	·477	2·889
Total .	21·19	28·661	22·57	22·16	26·840	55·891

Depth of Rain in 1836.

	Ackworth.	Bedford.	Boston.	Chiswick.	Empingham.	Epping.	London.
	Inches.	Inches.	Inches.	Inches	Inches.	Inches.	Inches.
January .	1·65	2·095	1·11	1·79	1·63	2·221	1·599
February .	2·02	1·3	1·87	1·61	2·19	1·614	2·056
March .	3·39	3·887	2·24	3·3	3·5	3·877	2·43
April . .	1·48	2·413	1·6	2·98	1·75	2·662	2·488
May . .	·68	·696	·47	1·01	·25	·928	·808
June . .	2·72	2·334	1·48	1·66	1·81	2·065	·898
July . .	2·33	2·085	1·6	1·78	1·38	1·992	1·886
August .	·69	·918	1·22	1·97	1·06	1·352	.993
September.	2·1	2·243	2·38	3·81	1·88	3·317	2·773
October .	1·71	3·824	2·73	3·62	2·37	4·283	3·063
November.	4·67	3·218	3·46	3·6	4·56	3·732	2·108
December.	1·77	1·806	1·22	1·48	1·63	2·058	1·646
Total .							

Depth of Rain in 1837.

	Ackworth.	Bedford.	Empingham.	Epping.	Esthwaite Lodge.	Kendal.	York.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	3·28	2·991	3·96	2·018	5·323	3·431	3·09
February .	3·16	2·223	1·94	2·420	8·379	5·840	2·21
March .	·99	·599	·75	·237	2·776	1·985	·86
April . .	2·00	1·868	1·81	1·066	3·238	1·610	2·01
May . .	1·62	2·151	1·31	1·186	1·133	1·195	1 14
June . .	1·51	1·050	1·38	1·156	6·604	3·610	1·21
July . .	2·64	2·491	1·22	2·045	5·716	4·730	3·82
August .	1·39	5·845	2·01	3·199	3·409	3·113	1·31
September	2·13	2·392	1·88	1·206	5·175	4·181	1·80
October .	2·08	1·466	1·85	2·150	8·530	5·316	1·76
November.	1·65	1·911	2·21	1·893	9·662	6·180	1·28
December.	2·94	1·519	2·05	1·346	9·201	7·201	3·43
Total . .	25·39	26·506	22·37	19·922	69·146	48·392	23·92

Depth of Rain in 1838.

	Ackworth.	Bedford.	Empingham.	Epping.	Greenwich.
	Inches.	Inches.	Inches.	Inches.	Inches.
March . .	1·40	1·204	·91	1·222	·95
April . .	1·58	1·600	1·47	1·006	·55
May . .	3·38	·921	1·69	·635	1·40
June . .	2·61	3·016	2·77	3·586	4·60
July . .	1·82	2·253	2·47	2·222	1·85
August .	2·59	1·228	1·22	1·341	·95
September .	1·41	2·554	2·05	2·272	2·65
October .	3·31	1·791	1·50	2·380	1·80
November .	2·01	3·322	2·29	3·012	3·00
December .	·56	·846	1·03	2·282	1·60
	20·67	18.765	17·40	19·958	19·35
January, February .	4·35	·846	2·16	2·357	2·65
Total .	25·02	19·611	19·56	22·315	22·00

Depth of Rain in 1839.

	Aberdeen.	Ackworth.	Empingham.	Epping.	Falmouth.	Greenwich.	High Flats.	Kendal.	York.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	1·879	1·130	1·41	1·458	3·581	1·25	2·50	5·325	1·15
February .	·511	2·145	1 07	2·021	4·317	1·45	1·94	5·735	1·01
March .	3·418	3·210	2·26	1·862	3·672	1·65	3·07	6·065	2·83
April .	·762	·585	1·20	1·591	1·900	1·35	·78	1·256	·68
May . .	2·069	·385	·67	1·936	3·040	1·50	·50	·713	·32
June . .	3·002	4 845	4·46	2·217	1·402	1·70	5·25	3·103	2·88
July . .	3·234	5 135	3·50	2·802	7·134	3·44	6·55	8·461	3·38
August .	1·558	2 940	3·23	2·283	2·627	2·50	3·60	7·277	2·20
September	4·440	3 430	1·78	3·819	5·050	4·50	5·30	7·437	3·01
October .	3·409	3·405	2·43	1·571	2·279	1·75	2·49	3·297	2·75
November	2·041	4·545	4·09	5·037	7·411	4·00	5·40	4·355	4·09
December	4·758	1·850	1·97	3·688	8·392	2·45	2·90	4 941	2·13
Total .	31·081	33·605	28·07	30·285	51·805	27·54	40·28	57·965	26·43

Depth of Rain in 1840.

	Aberdeen.	Empingham.	Epping.	Falmouth.	Gosport.	Greenwich.	York.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	2·427	1·87	2·938	6·414	4·220	2·92	2·740
February .	2·103	1·13	1·260	3·815	3·225	1·38	1·530
March .	0·746	0·27	0·453	0·189	0·180	0·33	0·380
April . .	0·385	0·60	0·047	0·505	0·380	0·11	0·980
May . .	2·631	2·95	3·190	1·975	1·665	2·10	2·360
June . .	2·073	1·90	1·346	1·229	1·370	1·50	1·730
July . .	1·571	2·60	1·206	2·819	2·570	1·58	2·570
August .	2·023	1·23	1·305	1·920	1·745	1·02	2·110
September .	3·204	1·57	3·043	3·138	4·430	2·65	3·320
October .	2·672	1·27	2·014	1·612	1·085	1·50	1·460
November .	3·163	2·76	3·461	6·470	6·070	2·70	3·740
December .	1·629	0·43	0·504	1·425	0·585	0·45	0·740
Total . .	24·627	18·58	20·767	31·511	27·525	18·24	23·660

Depth of Rain in 1841.

	Aberdeen.	Empingham.	Epping.	Falmouth.	Greenwich.	Thwaite.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	2·301	2·050	2·353	3·539	2·981	0·71
February .	2·949	1·060	1·245	3·953	0·979	0·95
March . .	1·227	1·030	1·613	4·521	1·280	1·24
April . .	0·774	0·930	1·511	2·322	1·910	1·14
May . .	1·499	1·330	1·593	3·515	1·812	1·45
June . .	1·734	3 070	2·997	2·513	2·118	1·67
July . .	2·672	2·100	3·163	2·444	4·311	3·86
August .	3·267	2·850	3 252	2·795	1·699	2·36
September .	1·985	2·690	4·426	8·510	3·860	3·80
October .	4·280	2·720	6·713	4·626	5·501	5·10
November .	2·438	3·040	4·440	9·383	4·019	2·51
December .	2·262	1·560	3·022	5·244	2·290	2·535
Total .	27·388	24·430	36·328	53·365	32·760	27·325

Depth of Rain in 1842.

	Allen-heads.	Birming-ham.	Epping.	Gosport.	Green-wich.	Har-raby.	Kendal.	North Shields.	Star-field.	Thwaite.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	1·889	2·025	1·552	2·106	1·072	2·331	3·503	2·976	1·267	0·37
February .	2·471	1·290	1·639	2·206	1·038	1·315	2·716	0·484	0·741	0·96
March .	5·188	2·690	2·602	2·237	2·151	2·962	5·983	0·450	2·513	3·02
April . .	0·684	0·555	0·326	0·600	0·509	0·418	0·551	0·404	0·496	0·32
May . .	3·153	2·490	2·362	1·800	2·400	1·671	3·255	0·972	2·913	1·51
June . .	2·637	1·110	2·285	1·975	1·180	1·849	4·377	1·015	2·640	1·05
July . .	4·062	2·770	3·591	1·743	2·712	2·529	5·877	2·302	4·598	3·18
August .	3·186	1·655	2·118	3·250	1·818	1·675	3·130	1·561	1·718	0·62
September	6·262	2·995	3·956	3·525	4·294	1·812	1·508	2·133	2·439	4·57
October .	3·608	0·885	2·029	1·187	1·563	1·795	2·924	1·650	1·883	1·94
November	5·158	4·500	5·163	6·950	4·731	1·925	7·232	2·288	3·461	3·64
December	3·391	0·800	1·140	1·831	0·738	1·543	7·016	0·567	1·313	0·61
Total .	41·689	23·765	28·763	29·410	24·269	21·825	48·072	16·802	25·982	21·79

Depth of Rain in 1843.

	Ack-worth.	Epping.	Green-wich.	Kendal.	Retford.	Roch-dale.	Settle.	Thwaite.	Wigton.	York.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	1·28	1·16	1·25	5·29	0·97	5·06	5·04	1·17	2·96	1·02
February .	2·91	1·87	2·68	1·04	2·87	1·42	1·21	1·84	1·42	2·65
March .	0·91	0·68	0·51	1·90	0·61	1·93	1·39	0·61	0·99	0·89
April . .	1·82	2·37	1·86	7·72	2·61	6·36	6·68	1·52	4·89	2·23
May . .	2·50	5·89	4·14	3·70	3·57	3·75	4·73	3·21	3·31	2·81
June . .	2·03	1·76	1·27	5·12	2·18	3·05	1·63	1·69	2·16	1·86
July . .	3·89	3·69	2·54	7·26	1·59	5·81	4·75	1·83	5·97	2·67
August .	3·59	2·73	4·10	6·37	2·49	3·90	2·82	4·45	4·17	4·09
September	1·05	0·44	0·44	0·40	0·31	0·69	0·52	1·18	0·55	0·42
October .	3·86	6·19	4·50	7·88	3·03	8·35	10·38	4·98	5·03	4·59
November	2·21	2·26	2·13	9·11	2·07	4·47	5·73	2·26	4·21	2·21
December	0·20	0·89	0·31	2·52	0·37	1·15	1·04	0·02	2·05	0·22
Total .	26·25	29·93	25·73	58·31	22·67	45·94	45·92	24·76	37·71	25·66

Depth of Rain in 1844.

	Ackworth.	Devonport.	Emping-ham.	Epping.	Greenwich.	Retford.	Settle.	Thwaite.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	1·520	2·733	1.270	2·451	3·190	1·120	3·240	1·50
February .	2·040	3·427	2·250	3·287	2·888	1·050	3·520	1·69
March .	1·770	3·474	2·100	2·206	3·018	1·750	4·520	2·31
April . .	0·210	0·826	0·100	0·387	0·380	0·170	1·150	0·30
May . .	0·400	0·075	0·270	0·359	0·315	0·410	0·000	0·36
June . .	1·630	1·133	0·900	1·946	2·093	1·710	2·320	2·29
July . .	2·650	1·512	3·000	2·444	3·061	2·860	3·760	2·41
August .	2·120	2·166	2·200	2·419	1·943	1·710	2·880	2·40
September	1·990	1·116	2·000	1·903	1·135	1·950	2·320	1·66
October .	1·550	2·886	2·950	4·710	4·084	1·380	1·970	4·34
November	2·430	6·687	3·620	3·915	4·701	2·120	1·380	2·84
December	0·480	2·036	0·570	0·429	0·401	0·210	0·380	0·52
Total .	18·820	28·101	21·230	26·486	27·212	16·440	27·440	22·62

Depth of Rain in 1845.

	Epping.	Empingham.	Greenwich.	Retford.	Thwaite.
	Inches.	Inches.	Inches.	Inches.	Inches.
January .	2·729	1·500	2·483	0·857	2·03
February .	0·753	0·760	1·004	0·875	0·46
March . .	2·063	2·150	1·471	1·256	1·12
April . .	1·201	1·370	0·697	1·365	1·75
May . .	1·340	2·900	2·247	2·758	2·95
June . .	2·506	2·410	2·031	2 610	1·24
July . .	2·078	1·680	2·036	3·150	1·83
August .	2·293	3·720	3·227	5·750	3·32
September .	1·818	2·150	2·152	1·810	1·27
October .	1·560	1·700	1·350	2·145	1·94
November .	2·442	1·300	2·583	0·750	2·23
December .	2·872	2·970	2·850	2·445	2·81
Total .	23·655	24·610	24·131	25·771	22·95

Depth of Rain in 1846.

	Ackwor.	Chiswick.	Empingham.	Epping.	Falmouth.	Greenwich.	Keswick.
	Inche	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	2·14	2·850	2·100	3·915	5·923	3·090	5·112
February .	0·51	1·470	0·520	1·173	1·888	1·305	4·840
March .	0·73	1·090	0·700	1·240	4·671	1·025	8·542
April . .	5·94	3·930	3·400	2·744	1·572	2 910	4·546
May . .	0·84	1·350	1·250	1·135	3·119	1·610	1·724
June . .	2·00	0·800	0·400	0·391	1·492	0·665	4·710
July . .	2·50	1·780	1·990	1·324	3·875	1·740	9·320
August .	4·07	4·500	3·650	3·667	1·756	5·210	4·676
September	0·90	1·760	2·050	2·702	1·444	1·917	2·902
October .	3·89	5·540	4·950	5·422	5·473	5·265	12·248
November	1·57	1·430	0·800	1·305	3·909	1·330	6·472
December	0·97	1·210	1·050	1·044	3·732	1·180	2·586
Total .	26·07	27·710	22·860	26·062	38·854	27·274	67·678

Depth of Rain in 1847.

	Chiswick.	mping-ham.	Epping.	Falmouth.	Greenwich.	Helstone.	Thwaite.	Witham.
	Inches.	nches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
January .	1·310	·750	1·772	4·773	1·335	3·710	0·520	1·140
February .	0·940	·150	1·297	2·311	1·675	1·830	0·470	1·460
March .	0·410	·850	0·921	4·568	0·739	3·220	1·130	1·250
April . .	0·920	·720	1·322	3·077	0·860	2·830	1·390	1·350
May . .	1·590	·350	2·386	4·145	1·245	2·830	1·750	1·210
June . .	1·310	·500	2·332	2·190	1·443	1·630	3·340	2·610
July . .	0·790	·700	0·963	1·408	0·710	1·590	0·990	0·330
August .	1·500	·050	1·442	1·332	2·330	1·170	1·660	1·680
September	1·660	800	2·289	2·193	1·767	2·380	1·770	1·100
October .	1·750	500	2·112	5·689	2·000	5·350	2·400	1·560
November	2·260	250	1·834	3·510	1·965	6·400	1·860	1·550
December	1·810	060	2·585	7·005	2·050	5·840	2·420	2·360
Total .	16·250	680	21·255	42·201	18·119	38·780	19·700	17·600

XXXIII.—*On the Farming of Somersetshire.* By Thomas Dyke Acland, Jun.

Prize Report.

If the farming of Somersetshire has no other claim to attention, it has at least the interest of variety. This county furnishes examples of almost every kind of soil, subsoil, and climate found in England; it is therefore difficult to describe its agriculture under a systematic arrangement or within a smal compass. Its grass lands include breeding, grazing, and dairy districts equal in their respective qualities to any in England. Among its arable soils are to be found a rich alluvial deposit, a sandy loam, red marl, peat and fen lands, heavy clay and thisty stonebrash, flint, gravel, and chalk.

The geology of Somersetshire includes specimns of nearly all the formations which appear on the surface o England from Wales to Norfolk—the grauwacke in the hills f Exmoor and Quantock; the old red sandstone and mountan limestone in Mendip; the coal-measures among the hills nea Bath; the new red sandstone and marls in the vale of Taunton Dean and at the base of many of the hills; the lias, which bouds the Bridgewater Level like a sea cliff, or rises out of itin patches like islands; the oolite formations, extending over th south and east of the county; the greensand and chalk, which appar in the Chard and Crewkerne hills, and in the table-land bween Somerset and Devon; and lastly, an extensive alluvial depo, partly covered by peat and fen land, which fills up the Bridgewter flat.

The physical aspect of the county is muclvaried. If the reader will take the trouble to glance at the mexed physical map, and to compare it with the geological m, he will notice the general correspondence of a great part of thcounty boundary with the line of the Watershed, from which theaters flow northwards into the Bristol Channel, and will percei that the county of Somerset naturally arranges itself in three rin divisions, viz., *a Central Basin,* draining into the Bristol Chael between *two hilly districts*, one on the west, the other on thorth-east.

If, to avoid needless precision, the Quan:k and Brendon hills be taken as the boundaries of the *Weste district*, and the Mendip range as that of the *North-Eastern,*e *Middle district* will then be nearly, but not strictly, coinciderwith the physical basin, the waters of which find their way intBridgewater Bay by the channels of the Axe, the Brue, and thParret.

The western district contains the schistosnd stony soils on the grauwacke, with occasional bogs; the clate is moist, and the streams abundant. Breeding and rearinstock characterize

PHYSICAL MAP OF SOMERSETSHIRE.

REFERENCES TO NUMBERS ON MAP

1. Bristol
2. Bath.
3. Wells.
4. Frome.
5. Glastonbury.
6. Bruton.
7. Alfred's Tower.
8. Castle Cary.
9. Somerton.
10. Bridgewater.
11. Wellington.
12. Taunton.
13. Langport.
14. Ilchester.
15. Yeovil.
16. South Petherton.
17. Crewkerne.
18. Milborne Port.
19. Chard.
20. Ilminster.

EXPLANATION OF MARKS

The Boundary of the County is marked thus .....

The Boundaries of the Districts into which the County is divided in the Report, thus — — —

The Line of the Watershed............thus

The Turbary Moor..............thus

The Peatmoor, as Sedgemoor, &c. ...thus

The Alluvial Grazing and Dairy Lands, thus

Western District..................marked W.

Middle do. .... do. M.

Eastern do. .... do. NE.

OUTLINE OF THE GEOLOGY OF SOMERSETSHIRE.

REFERENCES TO NUMBERS ON MAP.

EAST.

1. Bristol
2. Keynsham
3. Clevedon
4. Abbots Leigh.
5. Dundry.
6. Chew Magna
7. Bath.
8. Congresbury
9. Uphill.
10. Axbridge.
11. East and West Harptree.
12. Norton St. Philip.
13. High Bridge.
14. Wedmore
15. Wells
16. Shepton Mallet.
17. Cranmore
18. Welton Priors.
19. Frome
20. Alfred's Tower.
21. Bruton

CENTRAL.

22. Pennard.
23. Glastonbury.
24. Westhay and Turf Moor
25. Mark Moor
26. Mendip Hills.
27. Polden Hills.
28. King's Sedgmoor.
29. Bridgewater
30. Huntspill Clyse.

WEST.

31. Hunstile Farm
32. Quantock Hills.

WEST—continued.

33. Watchet.
34. Minehead.
35. Dunster.
36. Cleeve ... Farm.
37. Exmoor.
38. Mole's Chamber
39. Molland Down.
40. Exford
41. Winsford
42. Brendon Hill.
43. ... Farm.
44. Wiveliscombe
45. Milverton
46. Dulverton.
47. Wellington.
48. Taunton.
64. Dunkery F...

SOUTH.

49. Blackdown Hills.
50. Chard
51. Ilminster
52. South Petherton.
53. Langport
54. Compton Dundon.
55. Somerton.
56. Ilchester.
57. Crewkerne
58. Combe Farm.
59. Yeovil.
60. Sherborne
61. Milborne Port.
62. Castle Cary.
63. Wincanton.

ARRANGEMENT OF STRATA.

A. Devonian
B. Lower Carboniferous.
C. Old Red Sandstone.
D. Mountain Limestone.
E. Coal-measures
F. Dolomitic Conglomerate.
G. New Red Sandstone.
H. Lias
I. Oolite.
Ia.
Ib.
K. Greensand
k. Chalk
L. Alluvium
Rich Soils
Clay

[To face page 666.

its farming. The geology of the eastern district is very complicated: its most prominent features are mountain limestone, coal-measures, and the oolites. The climate is foggy; but some of the pastures are remarkably dry. Dairy-farming predominates. The middle district includes the principal grazing and cheese lands, the peat-moors, the stonebrash and clay soils on the lias, the oolite sands, and the new red sandstones and marls. It may be well to mention, as an illustration of the state of agricultural statistics in this country, that I have not been able to obtain from any public department (including that of the Ordnance Survey) an accurate statement of the area of the county. The following approximation is extracted from the population returns of 1841:—"The area of the county is 1645 square miles, and therefore 1,052,800 acres; the area assigned to the different parishes amounts to 1,089,099, but no attempt to reconcile this apparent discrepancy has been deemed allowable." According to the same returns the number of inhabitants of the county is 435,982, being in the proportion of 42 persons to every hundred acres, that of all England being only 43 to 100 acres.

The proportion of grass-land in the county is very large. Mr. Billingsley,* a landed proprietor residing in the county at the end of the last century, in a report to the Board of Agriculture, which shows him to have been far in advance of his time, estimates the enclosed grass-lands at 584,500 acres—above half the county, and the commons and wastes at 115,000. There are now probably about 40,000 acres unenclosed, of which about 30,000 are in the Western hilly district.

Western District.

The WESTERN HILLY DISTRICT consists of the following groups:—

1. *The Quantocks*, which run from N.N.W. to S.S.E., and are isolated by the new red sandstone, which overlies their base on all sides. The principal heights range from 1000 to 1100 feet above the level of the sea. "Will's Neck," the highest point, is 1270 feet.

2. *Brendon Hill*, which lies from east to west with Main Down, Heydon Down, and Haddon on its south side; Croydon Hill and some other hills on its north side; all lying in the same direction. Haddon Hill rises to 1140 feet, and Brendon Hill somewhat higher.

3. To the west of Brendon Hill, and divided from it by the deep stream valleys which fall to the north and south from the

* 'General View of the Agriculture of the County of Somerset.' By John Billingsley, Esq., of Ashwick Grove, near Shepton Mallet. p. 12.

watershed at Wheddon Cross Cutcombe, is *Dunkery*, connected on the north with the *Porlock* Hills and the coast-line, and on the west with the *Forest of Exmoor*. On the south side of Dunkery are the Winsford and Hawkridge Hills, which are a continuation of the ridges of Exmoor. All these hills lie east and west, or nearly so, which causes a remarkable distinction in the agricultural character of their north and south faces. Dunkery rises to the height of very nearly 1700 feet;* and the heights of the adjacent hills vary from 1000 to 1500 feet above the level of the sea.

Sir Henry Delabeche, to whom every square mile of West Somerset and North Devon is familiar, has noticed the varieties of agricultural character which appear as you go from the Bristol Channel to the south across the successive bands of the grauwacke or Devonian formation running from east to west, till we touch, for a short distance, on what is now called the lower carbonaceous formation.

The differences in the several bands of rock noted by the geologist, resolve themselves into two classes of soil, well known to the local agriculturist—"stone rag" and "stone rush," which last is probably the same word as *brash* or broken. The "stone rag" is a soil composed of finely laminated layers of clay-slate, which have a tendency to rub down into clay and to hold moisture. The "stone rush" is a soil in which irregular portions of stone work up to the surface, where they are slow of decomposition. As a general rule the "stone rag" is more favourable to the growth of grass, and is considered as worth from 5*s*. to 10*s*. an acre more than the "stone rush," which is apt to suffer from drought. The "stone rush" is also an unsuitable soil for the action of any agricultural implements which are liable to be damaged or impeded by stones.

Farming of the Western Hill Country.—The farming in this district is not without its interest. The proprietors, it is true, cannot have the satisfaction of showing their friends a state of excellence attained; but for those who bring kindness, patience, and good sense to the task of improvement, it has the livelier interest of hope. "Liberal landlords and grateful tenants" was the motto chosen recently by a distinguished farmer. It expresses well the conditions required to renovate a wild district, without sweeping changes.

Some years ago many of the estates in the Hills were let on leases for lives. It is needless to point out here how that kind of tenure works ill both for landlord and tenant, and is a barrier

* I am indebted to Captain Denham for the information that his survey data of 1832 give Dunkery an altitude of 1697 feet above the half-tide level of Porlock Bay.

to improvement in various ways. It is now fast coming to an end. In the mean time, in certain cases, the landlord has mitigated the evil by becoming the tenant of his lessee for the remainder of the term, in order to commence the repair of the premises before they are given up in a hopeless state of dilapidation. This plan, however, can rarely be adopted, except in cases where the lessee is not himself resident. When the arrangement can be effected, the owner in fee regains the power of removing a hopelessly bad tenant, or of giving encouragement and confidence to a good one. To avoid being called upon for dilapidations, the lessee will accept less than the full rent which the tenant will gladly pay for improved buildings.*

The estates of the Hill Country may be ranged in three classes:—1. Farms rented at from 50*l.* to 70*l.* a year, with a small quantity of water-meadow (from 10 to 15 acres), about 60 or 70 arable, and perhaps 100 acres of rough old pasture, and a right of common. 2. Farms rented above 100*l.* and under 200*l.* a year, with about 30 acres of meadow, 120 acres of arable, and the same of pasture, with common rights. 3. Farms with rents ranging from 200*l.* to 300*l.* (not many in number), containing fron 30 to 60 acres of water-meadow, 150 to 200 arable, and a considerable extent of pasture, and common rights. The quantity and quality of the water-meadow is the object of prime consideration in fixing the rent.

In this classification, and in the remarks which will follow on the husbandry of the Hills, it will be understood that the old Hill Country estates are alone referred to, and that the recently enclosed farms of Exmoor are not included, unless specially named.

The tenants of the smaller farms are not generally men of much capital, and their fare is as simple as that of labourers;

* The life-lease system is expiring, but is manifesting all the evils of the end that can have been foretold. Ruin to the land and to the buildings is everywhere permitted; the payments for dilapidations generally evaded; whole districts appear to the traveller disgraceful to the owner and occupier;—but the remedy is so expensive, that it must require years to drain, cleanse, and build enough to renovate the lands that are in process of exhaustion. The evil is aggravated by the way in which the fields of one lessee are intermixed with those of another—so mixed probably to give each lessee a share of the good and the bad, of the arable and of the pasture, of the meadow and of the orchard, of the wet and of the dry. The course which I have found to answer best is, to fix the spot where the future farmer should reside, to build thereon as soon as it is out of lease, and to let all the land within a given boundary to a tenant who will occupy each field as it ceases to be held on lives. It is his interest to aid me to prevent dilapidation; and he often is able to become the tenant of the lessee before the premises are worthless. There are some lessees who are exceptions to this general censure, but they are rare. In some cases, when the lessee is taking care of the estate, or might be induced to do so with a better tenure, it is desirable to convert the life term into a term certain, making him the occupier of a district instead of a new tenant, as it is expedient, as much as possible, to continue the attachments that exist.—PORTMAN.

but among them are some very industrious men, who have been enabled to turn the corner, and to save enough to begin to improve their turnips and their stock.

The largest farms under the third head are generally in the hands of men possessed of capital and intelligence, while the occupiers of the farms of intermediate dimensions (the most numerous class) are endowed with those needful requisites in very various proportions to their respective holdings.

Of the tenants generally, it must be said that they show feelings of warm attachment to those with whom they have been long connected and who have gained their confidence. There is, moreover, about the genuine hill-countryman a certain activity and a shrewdness which rarely forsakes him—qualities not inconsistent with slovenly habits of farming and a limited circle of ideas, all more or less the result of his circumstances, and containing, like the soil, the elements which repay and those which retard the success of patient cultivation. He is many miles from a market town, with the sea on the north and the forest on the west; he has, therefore, comparatively few opportunities for intercourse with others, and is chiefly dependent for his ideas on the traditions of former generations, his own observation, and the improvements which may be brought into the district by owners of property or new tenants.

I will endeavour faithfully to exhibit the merits and the faults of the traditional practice, and the improvements which practical men have introduced into the district, and in doing so to notice the points prescribed by the Council for consideration in this Report, viz. :—

1. The alternate system of corn and grass;
2. Catch-meadows;
3. Turnip-husbandry; and,
4. Reclamation of moors.

"The alternate system of arable and grass cultivation, and the advisability or otherwise of abandoning it."

It is necessary first to understand what is the system referred to. There is on some estates an alternation of tillage and grass which hardly deserves the name of a system of cultivation, being in fact only a habit of extracting from the earth all its spontaneous produce in corn, and then leaving it to rest—that is, to accumulate vegetable matter and ammonia from the atmosphere. About such a practice there need be no question.

As a system, it is confined to farmers of no capital, who adopt it because they cannot carry on a regular system of green crop cultivation, or by farmers who occupy more land than they can keep in a regular course; and who, tilling their best land re-

gularly, keep their rough high fields for summering-ground and for the run of young stock, breaking them up occasionally when the moss gets the better of the grass.

In order to give a practical answer to the question propounded by the Council, the common modes of cultivating corn crops in the hills must be explained. The reasons for the improved practice of the best farmers will then be more intelligible.

For the substance of much that follows on the ordinary wheat and turnip husbandry of the hills I am indebted to the Rev. Bennett Michell, Rector of Winsford, who farms his glebe, with great benefit to the secluded valley in which his lot is cast, and not without profit to himself.

After a field has been in grass for some years, till all the valuable grasses are extinct, and the field is full of moss and couch, it is broken up, either for wheat in the first instance, or— 1, oats, "to clean the land," as they say; then 2, wheat; 3, turnips; 4, oats, or wheat; and 5, grass.

When the wheat is sown at once, from 30 to 50 bushels of lime, without any other manure, are spread. The land is once ploughed, and sometimes hacked over by manual labour with a mattock, at a cost of 6*s*. per acre. The seed is sown broadcast, and harrowed in. The turf, or spine, is, however, so tough that the seed-bed is very shallow, and the furrows lie so hollow that the surface-earth is soon washed down into them by the heavy rains of November and December, so that the roots are left half naked, and the plant often sadly thinned out by the frost. But a worse evil remains—the couch-grass is greatly encouraged by the land having been broken, but not cleaned, in the autumn. It is not the common couch (Triticum repens), but a kind of bent grass (the Agrostis vulgaris), a still more troublesome weed. This overpowers the wheat in its early stage, and fills the sheaves in harvest-time with moist grass. The harvests in the hill country are always late, and the weather generally unsettled; therefore the delay of a day in the drying of the sheaves often ruins the crop. The labour of cleaning the land in the spring is very great, and if the season is wet the toil is fruitless, and the land is left in the worst possible state for turnips.

Notwithstanding these obvious evils, wheat is still cultivated in this manner by many farmers; but "an oat-crop to clean the land" is more common. This maxim, like most local sayings, has its foundation, though an imperfect one. If the land be broken in the spring, some of the couch may be taken out, and what is left finds the comparative dryness of the summer months less favourable to the spreading of its roots than the moisture of winter after an autumn-ploughing. The crop of ley oats is taken without any manure. After harvest the land is scarified,

to cause the dropped oats to vegetate; it is then limed, and ploughed for wheat; and though the plan is defective enough, the wheat crop is found to be better after oats than when it has to maintain a vain struggle with a flourishing crop of bent grass.

Instead of this course, a better system has sprung up among farmers of capital and intelligence. Mr. Roals of Brendon farm set the example of laying down the land for grass after a root crop, without any intervening corn crop, about thirty years ago, on the top of Brendon Hill, at an elevation of 1000 feet above the sea, when he was forming the water-meadows described in this Journal, vol. vi. p. 518. Mr. Corner of King's Brompton carries the system of root cultivation one step further, by beginning as well as ending the tillage with turnips.

The old rotation and the new may be thus placed in contrast:—

Old.	New.
1. Ley Oats.	1. Ley Turnips or Rape.
2. Wheat or Oats.	2. Oats or Wheat.
3. Turnips.	3. Swedes.
4. Oats.	4. Grass.
5. Grass.	

On the plan of the new rotation the ground is broken up in the spring, about the time at which ley oats are usually sown, and prepared for early turnips or rape, which will be fit to be stocked in August and be eaten off by October. The land will have been well manured and trodden by the sheep, and a clean fallow (unless the season should have been very wet) will have been prepared for wheat or oats. The crop of swedes will follow the grain crop, and the grass seeds will be sown in the following spring.

On this point of management we may consider the opinions of the best farmers agreed—namely, that with a view to the great object of this essentially rearing country, a portion of the farm should be laid down in grass after roots.

The question arises, how long the grass is to remain. To this no general answer can be given. It depends partly on soil, partly on degree of exposure, and partly on the season. I have taken some pains to ascertain the opinion of farmers differently situated; and I think that which most generally prevails is, that if the soil be a stone rag, retentive of moisture, the situation not too exposed, and the season favourable, the cultivated grasses may be expected to continue out for 3 years:—that under the opposite conditions they will certainly not remain out more than two years, and probably not often survive a second winter. All that has been said refers to grass in alternation with tillage. But grass is sought for in the hill country in two other forms—permanent pasture and water-meadow.

The subject of *permanent pasture* has engaged a great deal of attention, and the opinion of the most intelligent men is, that

where the pasture rests on a deep soil in sheltered situations, and is naturally sweet, it should not be disturbed, but stocked with judgment and care, and occasionally dressed with lime. A yeoman farming his own land endeavoured to improve some ground of this kind. He broke it up—sowed turnips twice, and no corn, and seeded out; and, after 4 years' expense, he left it worse than when he began. He then dressed it with lime and earth, and in time it came round again. On the other hand, when the land is light and high, it must be broken from time to time, or it will become mossy and worthless.

The great instance of successful practice with permanent pasture is that of J. W. Blake, Esq., of Venne House, on Brendon Hill, marked on the Ordnance Map "four Chimnies."

Mr. Blake, finding the soil of his estate not suited to the ripening of seed, but very favourable to the growth of grass, has been for some years engaged in its improvement with a view to the formation of good permanent pasture. This he has effected by draining, liming, and sowing a carefully made selection of the most permanent grasses. In a few instances he has given a dressing of bones, or irrigated with pond water.

He lets his fields annually by auction to farmers, graziers, and butchers from great distances. He has been kind enough to furnish me with particulars of the original value of each field, the way in which it was treated, and of its letting in the years 1848—1849. The statement is too much in detail for this Report; but the following is the general result:—

The Venne farm, consisting of 233 acres, was let for a term of 21 years in 1802, at a rent of 100*l.* per annum: it was valued at 115*l.* for a new poor-rate in the year 1832. The lettings of 166 acres of improved grass out of the 233, in 1849 produced 365*l.*

The Cooksley farm, consisting of 129 acres, was let in 1832 for 45*l.* The lettings of 95 acres of improved grass out of the 129, in 1849 produced 176*l.*

The following arrangement of the several parcels of land on one of the farms will probably be more satisfactory than a mere general statement:—

Acres.	Original State in 1832.	1832. Net Value per Acre.	1832. Letting to a Tenant.			1849. Gross Amount paid per Acre.	1849. Lettings by Auction.		
			£.	*s.*	*d.*		£.	*s.*	*d.*
$44\frac{1}{2}$	Arable, at . . .	6*s.* to 10*s.*	16	2	0	38*s.*	84	5	0
$42\frac{1}{2}$	Pasture, at . .	3*s.* 6*d.* to 15*s.*	13	17	2	30*s.*	64	0	0
$7\frac{3}{4}$	Water-meadow, at	17*s.* to 23*s.*	7	3	6	70*s.*	28	0	0
$94\frac{3}{4}$			37	2	0		176	5	0

From the increased rental (which includes the tithe) deductions must be made for rates and taxes, as well as for the triennial dose of lime referred to below. The tenants pay 1*s.* per acre to the shepherd, who takes care of the stock and keeps up the fences.*

The soil on which these improvements have been effected, all rests upon a substratum of grey slate (stone rag). The surface, as Mr. Blake found it, was in three different conditions:—1. Peat, to a depth of 5 feet, between which and the slate rock a layer of clay is interposed. 2. Old worn-out arable land. 3. Old grass-fields, and open common which had never been cultivated, but was covered with fern and short English furze.

Mr. Blake thus explains his mode of management:—

"My mode of draining varies with the soil—the most extensive being the peat bogs, requiring gutters from 4 to 7 feet deep, and from 20 to 30 feet apart, the expense varying from 1*s.* 2*d.* to 2*s.* 3*d.* per rod for digging, getting, drawing the stones, and filling in. The furthest distance for the carriage of stones does not exceed a quarter of a mile. The cost of drains per acre is from 5*l.* to 9*l.* 10*s.* The soil consists of from 3 to 5 feet of peat, 1 foot clay, and 1 foot of a mixture of stone rag and clay, on which it is necessary to use the pickaxe. This subsoil contains the springs and forms a good bottom for the *stones*, which I much prefer to pipes. I have been obliged to take up several gutters laid down with 1¼ inch and 1½ inch pipe, on account of their being quite filled with small fibrous roots the second summer. I think the pipes are better adapted for strong clay, into which the roots do not penetrate.

"On the fresh-drained peat-bog, after spading and burning, and ploughing (if it will admit the horses; if not, trenching), I lay on 100 bushels of lime per acre in the most caustic state—being slaked with water, laid on hot the same day and harrowed in immediately. This I do two seasons following, before each crop of turnips, and it is this plan I have found to answer so well. In this way I succeed in decomposing the sour peat, which before produced nothing, into as fine a mould as you would desire for a garden; and in three or four years it will grow any of the clovers.

"I had three or four old grass-fields, which are much improved by top-dressing with lime and earth, at the same time sowing grass seeds for renovating old pasture, and rolling it over several times with a small spike roller—the spikes 1½ inch long, and 2 inches apart. I think Crosskill's would answer well for this purpose. The larger portion was old arable land quite exhausted by overcropping.

"The quantity of lime which I generally use is 50 bushels per acre, about every three years; which I find, used either for top-dressing or fallow, to have a much better effect than 75 or 100 bushels at longer intervals."

Mr. Blake has furnished me with a list of seeds which he obtains from a London seedsman, in the following proportions, at a cost of about 20*l.*:—

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* The lettings, however, after making these deductions, must not be supposed to represent the actual value of the land, nor the price at which it could be profitably taken by a grazier: the lots are in fact frequently taken by farmers who are short of keep as a matter of necessity, in order to avoid selling their stock at a disadvantage.

3 bushels Dactylis Glomerata (very good for after-grass).	18 lbs. Cynosurus Cristatus.
3 bushels Festuca pratensis.	15 „ Poa Nervata.
3 „ Alopecurus.	15 „ Poa Angustifolia.
3 „ Holcus Avenacens.	12 „ Poa Fertilis.
3 „ Lolium Italicum.	10 „ Poa Pratensis.
3 „ Festuca Duriuscula.	10 „ Anthoxanthum Odoratum.
15 lbs. Poa Trivialis.	40 „ Trifolium Medium.
42 „ Phleum Pratensis.	40 „ Trifolium Pratense.
	9 „ Agrostis Stolonifera.

To the above selected seeds are added—

50 lbs. of ribbed grass,
40 „ of early dwarf rape,
50 „ of alsike hybrid clover,
5 bushels of Italian rye grass,

at a further cost of 5*l.* The total cost is about 25*l.* for 12 acres. The grasses have maintained their quality for many years.

"*The formation of Catch-Meadows in Valleys or Mountain-sides, with an account of the Improved Value thus given to the Land.*"

If this subject had not been prescribed for the present Report it might have been passed over, as nothing can be added to the statement in a recent Journal on Catch-meadows, except by way of illustration.

Samples of each kind of water-meadow recently made on the hill-side and on the flat may be seen in one of the most beautiful spots in the West of England, on the ancient way from Dulverton to North Molton. They are close to Tarr Steps, a bridge over the Barle, composed of some twenty stepping-stones with cross stones of 8 or 10 feet in length, laid from one to the other like arches.

One of the meadows in question is made on the steep side of a hill; the other, on the bank of the river, was not long since a rough bramble-brake, the loss of which might be regretted by the lovers of the picturesque, if the smooth green velvet of the meadow had not its own charm. When I was on this meadow in January last, the difference between the herbage on the higher part above the level of the sluice, which had been manured with dung, and that on the part which had been watered, was in favour of the latter; and the waters of the Barle are by no means of the first quality for irrigation.

These meadows have been made by the Rev. Joseph Jekyll, who describes them thus:—

"*Hill-side Catch-Meadows.*—The cost is but trifling. The gutters should be cut with a spirit-level about 3½ perches apart, 4 inches deep, and 18 inches wide, decreasing in width (according to length) to not less than a foot. A 2-feet gutter may be required at the top, and also some intervening gutters of the same width as the water descends the Combe. This can be effectually done for 1½*d.* per perch; and as 50 perches will be required to an acre, the cost will reach 6*s.* 3*d.* per acre. My *valley meadow* of 7 acres is a flat uneven spot of land. It was filled with large

stones, covered with bushes and briars, and not worth 8*s.* per acre when I took it in hand. I merely cleaned and cropped it with turnips at a cost of 5*l.* an acre, and had a fair return for the outlay the same year; I then laid it down to grass, and the third year conveyed over it the Barle water in a 2-feet gutter, through its centre, cutting the smaller gutters, some at right angles, some serpentine, from the main gutter, according to the level. The expense of this, sluice and all, did not exceed 5*l.*; it is now worth 2*l.* per acre."

The expense is stated by Mr. Jekyll at an unusually low figure. It cannot be taken as including any spade-labour for filling up hollows, levelling, &c., and it assumes the power of the owner or occupier to lay out the gutters by his own skill.

Mr. Robert Smith on Exmoor is making some excellent meadows. If any one from the north-west of our island desires to see how to apply the system in a mountainous country, they can in no way obtain better information than by a visit to Mr. Smith's farm in order to see the operation from the commencement.

"*The defective Cultivation of the Turnip Crop and the best mode of Management—keeping in view the peculiar Moisture of the Climate.*"

It is needless to enter into minute details as to the defects of the practice of those who go on in the old way. They put in the seed with the shaker—a box 10 or 12 feet long with holes in it, carried by the sower in his hand. Their favourite manure is peat-ashes with lime and a little poor dung. There are some old farmers who still say they "don't hold with hoeing;" and some who thin the crop with the drags. If the charlock comes up thick, the gang of weeders turned into the field is a flock of lambs to pick off the flowers. The crop is finally consumed on the ground, with the exception of a few roots, which may be drawn off for the calves and yearlings, or to feed a beast or two.

But, in fact, the value of the turnip-crop is more generally appreciated than it used to be; and most of the farmers who have the means take some pains to obtain a good crop. Owing to the remoteness of the district and the nature of the ground, implements of a superior kind do not readily find their way into the hills; but the better class of farmers generally drill their turnips and keep them tolerably clean, and the value of superphosphate of lime is beginning to be generally known and admitted. The better cultivation of root-crops has been much promoted by Mr. Michell's example and readiness to explain to his neighbours the reasons and to show the results of his practice. The gradual course of improvement, and the best mode of management to be now adopted, cannot be better told than in Mr. Michell's words:—

"Guano was for some years extensively used and with great success, so

far as the turnip was concerned; but a more extended experience has convinced most farmers that their subsequent crops are not improved as they should be by the use of this manure; in fact, that the land appears to be impoverished rather than enriched after the growth of a good crop of turnips with guano, though they may be eaten off the ground; guano has consequently fallen greatly into disuse, and has given way to the less expensive and far more efficient dressing with superphosphate of lime. This is generally manufactured by the farmer himself by dissolving crushed bones in about one-third of their weight of sulphuric acid. This is used at the rate of from 2 to 4 bushels of bones per acre, carefully mixed with about ten bags of peat or wood ashes. The cost per acre—3 bushels of bones at 3*s.* per bushel, including carriage; 40 lbs. of acid, $1\frac{1}{2}$*d.* per lb., and ten bags of ashes at 7*d.*: the whole 19*s.* 6*d.* per acre. With this such crops of turnips are now grown in the hill district as would quite astonish the farmer of a quarter of a century ago. And when we consider the little labour required in carting this manure on the farm and depositing it on the land, it must be acknowledged to be the cheapest as well as the best of all dressing for the turnip. It appears too to be exceedingly well adapted to the climate and soil, so that any breadth may now be grown at a reasonable cost.

"The succeeding crops of corn and grass after the superphosphate are found to be very satisfactory, especially when a small portion of lime, far less than was formerly used, is combined with it. Lime appears to be indispensable to the successful cultivation of a hill farm; but when we include its cartage over bad and hilly roads—often too from a great distance, and the expense of its subsequent management, it is by far the most costly of all manures; its use should therefore be economized in every possible manner."

It may, perhaps, be premature to give a decided opinion on the relative advantages to the hill farmer of drilling on the flat and on the ridge. In the vale the question may be said to be decided in favour of the flat system. The points of improved practice for the hill, settled in the judgment of the majority of intelligent and active farmers, are the value and economy of superphosphate of lime, and the necessity of adopting some mode of drilling in order to use the horse-hoe. But hill farmers in general, not having been used to ridges in the days of broadcast sowing, and seeing that the superior farmers in the vale prefer the flat, naturally wait for a clear proof of the superiority of the ridges before they change to what they consider a more troublesome plan.

Before proceeding to speak of the reclamation of moors, I must refer to a subject closely connected with grass and root crops.

Management of Stock in the Hills.

Bullocks.—The breeding of North Devon steers is one of the chief objects of the hill farmer. More attention is paid now than formerly to the quality and shape of bulls, though there are still many farmers who will rather pay 2*s.* 6*d.* to send their cows to a common bull, than give 5*s.* for the use of a good one. The principle of keeping young stock in a constantly growing and improving state is rarely acted upon. A few turnips may be given to the calves and

yearlings; but even good farmers seem contented to let their young bullocks shift for themselves on any rough ground, or in strawyards in winter, till they are two or three years old. "What will that bullock *lose* between this and March?" is a question often put in jest to the farmers about the fall of the year, by a good friend of theirs from the north, who has lived among them for many years. Bullocks are sold off younger than they used to be. Out of 60 bullocks taken in to graze on Bradley Ham, near Withypool, 30 used to be full-grown oxen; now, hardly any are more than two years old. On the other hand, even the smallest farmers are learning the advantage of fatting some animals at home in winter for the sake of making better dung, and contrive, by means of the improvement in the growth of turnips, to finish off a barrenner or two. I heard of one hill farmer who sold 7 oxen just before last Christmas for 30*l.* a piece, but then, he is a farmer who would be in the first rank in any country. Let us hope that many more may yet do as well, according to the prices of their time. Another is making arrangements with his landlord to have house-room for 50 beasts. He intends to feed all that he breeds; but he thinks it the best plan in the hills to clear the yards of fat oxen by Christmas in order to be able to keep the rearing-stock well through the spring.

Sheep.—The sheep kept on the hills are a native breed, with small taper horns, known as the Exmoor or Porlock breed, called in the country Horned sheep, in contradistinction from Nott sheep, which have no horns. The hill country farmer generally keeps a breeding flock of horned ewes and a flock of wethers, which run on the hill summer and winter. The number of his ewes will be limited by the extent of his water-meadows, on which he relies in great measure for the keep of the couples after the lambs are dropped. The number of hill-wethers depends on the extent of the common-right attached to the farm. About the 20th of June all the sheep are gathered for sorting and shearing. The mouths of the sheep are examined, and those whose teeth are broken are drafted, and kept back from the hill to be sold or fatted off. The ewe hoggetts replace the draft ewes, and the wether hogs of the former seasons are shorn with the hill wethers, and turned off to the hill after being signed with some large mark which can be known at a distance. They cost nothing but the trouble of an occasional gathering till next year; and the only profit they yield is about 5 lbs. of wool. In their fourth or fifth year they may be brought into grass. They are also used as labourers on the farm, to eat the grass down close in the fall of the year; and are sometimes marched in close phalanx up and down a ploughed field, to tread in the wheat. The ordinary sheep of the country, when fat, do not weigh above 11 lb.

or 12 lb. a quarter. Where pains have been taken to improve a flock, they may reach on the average 16 lb. or 18 lb. a quarter; and some are brought up to 24 lb. a quarter, when fed in the Bridgewater Marshes. There is also great difference in the quality of the wool of a common and of a well-bred sheep. It is the practice of farmers, who have good land as well as common, to put their draft ewes with a small-headed and high-proof Leicester ram; to sell the lambs fat in May and the ewes as soon as they get fat. Fifty lambs bred in this way were sold out of the Vale of Porlock for 23*s.* a head at Taunton market, in May, 1848. The ewes, when fat, would fetch about 28*s.*

There are great objections to horned sheep. In the first place, it is almost impossible to prevent them from being infected with the scab while they are on the open hill: they also acquire such restless habits, that they are always breaking the fences when brought into the enclosed ground; in fatting them much judgment and practical knowledge is required, for they do not get on well in hot weather; and it frequently happens that when they are first put into turnips they lose ground, or pitch, as it is called, for two months in the autumn, and are slow in regaining it afterwards. For these and other reasons farmers who occupy good land in the vale with their hill farms are getting tired of the horned sheep, and use their hill farms only as summering-ground for nott sheep and bullocks. When they change their flock they generally do so gradually, by repeated crosses with Bampton or Leicester rams. It is supposed that a nott flock raised in this way is more hardy.

On a farm near Dunkerry Beacon, which includes some good land in the vale with summering ground and very poor heath on the hill, a different plan is in course of trial. Horned sheep are kept with a view to improve the breed on the hills. The flock has been in a steady course of improvement for eight or nine years, and is now become almost too tender for the commons. A young wether is more valuable before he is turned out than when he is a year older: it has therefore been decided to fat off the wethers as early as possible.* It is supposed that they will reach 16 lb. or 17 lb. a quarter, if kept on without a check, before the second summer's grass is over; or that, having acquired no restless habits, they may be finished on turnips without losing time. Some hoggetts were folded on a hill meadow last spring, and supplied with cut turnips; they did remarkably well, and greatly improved the field.

As we are now in the principal breeding district, it will save

* Since this report was sent in, I have had the satisfaction of learning that two of the best breeders of horned sheep have decided to adopt the same plan.

repetition hereafter to introduce in this place what is to be said on the subject generally.

Breeds and Breeders.—As a cattle-breeding district West Somerset is closely connected and yet not to be identified with North Devon. A line of noted breeders may be traced along the southern slopes of the high land from Exmoor to the Quantocks: they may be classed in three groups. At the western end the pure North Devons cluster round Mollond Down and North Molton; at the other extremity we find the heavier Somerset animal round the base of the Quantocks near Taunton and Bridgewater; between the two extremes are the bullocks of Brendon Hill round Wiveliscombe, which appear in a high degree to combine size and quality; nor must I forget to put in a claim for the sunny knolls and marshes of Dunster and its neighbourhood to occupy the same intermediate position in the character of its cattle.

It is remarkable how entirely the reputation, and it may be said the present existence, of the Devon breed is owing to tenant farmers, and above all to one man, Mr. Francis Quartly, of Mollond Botreaux. As the boundary of Somerset touches Mollond, and as his name is not even mentioned in the Report on Devon, it may be allowable to record in this Report the debt of gratitude which West Somerset owes to him. He is now advanced in years, and afflicted with blindness, but in full possession of his mental powers. The account which he gave in answer to my inquiries was to the following effect:—

More than fifty years ago the principal North Devon yeomen were all breeders: and every week you might see in the Molton markets animals that would now be called choice; there were no cattle-shows in those days, and therefore the relative value of animals was not so easily tested. The war prices tempted many farmers to sell their best bulls and cows out of the district; and Mr. Quartly in his youth perceived that good animals were becoming scarce, and the breed generally going back; he therefore determined to buy quietly all the good stock he could meet with. He often picked up a cow from a dairy farmer who wanted to get rid of her, because she would get so fat she gave no milk; after buying all the best animals he could find, he continued for many years, with that skill and judgment which great breeders alone can appreciate, to improve his stock till he brought it to perfection. About the year 1831 cattle-shows began at Exeter. Some good Devon breeders carried off the early prizes; but after a year or two Mr. Quartly allowed his nephews to enter in all the eleven classes at Exeter, and they brought home the eleven prizes. Mr. James Quartly says, that when he had to return thanks, he felt ashamed to think they should have been so greedy.

However, it was clearly proved where the fountain head of the breed was, and the Quartlys have kept the lead ever since. Two of Mr. Quartly's neighbours, Mr. Merson and Mr. Davy, have also kept up the breed in their families for more than a century. In West Somerset, Mr. Hole, of Knowle, near Dunster, has come into the field, and spares no expense or trouble to breed the very best. The names of many of the breeders and feeders near Taunton are so well known at Smithfield, that I may be spared the invidious task of selection.

Somersetshire breeders are divided in opinion as to the merits of the pure North Devon animal. Speaking generally it is not in high favour with the farmers of the richer lowlands: they say that it is too small, that it has not a sufficient proportion of lean meat, and that it is not hardy in constitution. I have also heard it maintained that when it is brought into the Vale it alters its character and becomes coarse. The concurrent evidence of practical men must not be set aside without careful examination, though we must guard against sweeping generalizations and the bias which each man feels in favour of what he rears and sells.

It appears that there are two important qualities requisite in breeding stock. First, the parental function of producing a healthy offspring and giving milk; secondly, the aptitude to fatten quickly: either of these qualities carried to an extreme tends to impair the other. Many breeders in pursuit of size have produced coarseness; others in quest of quality have found their breed degenerate in size and constitution, or come to a stand-still by frequent abortions. It is proverbially more easy to get up a good breed than to keep it up. Moreover, if bullocks are to work as beasts of labour, for which the Devons are so well suited, excessive smallness of bone and tendency to fat seem inconsistent with a due weight of muscle, and therefore with a fair proportion of lean meat for the butcher.

It would follow from the consideration of these facts that a strong constitution, faultless frame, and a power of giving milk should be secured in the female, and that the highest attainable tendency to fat which is consistent with good shape and constitution should be looked for in the male.

Bull-breeding, in this view, may be looked upon as a distinct art, for the successful prosecution of which the public are greatly indebted to Mr. Quartly and his competitors, and for which it may perhaps be true that the climate of North Devon offers especial facilities.

On the other hand it may be no less true that the Somerset pastures are favourable to growth and size, and that greater profit will be found in sending large cows to the high bred bulls than in seeking the purest blood on both sides.

Such at least appears to be the actual practice of farmers who look for their return to the butcher or grazier rather than to the sale of bulls and breeding heifers, and this view of the matter tends to reconcile the conflicting statements of practical men.

The following is the opinion of one of the most successful breeders and graziers near Taunton:—

"Especial attention should be paid to quality, evenness of flesh and points, with a sound constitution, regardless of size; though I prefer middle-sized animals, as most approved at market. I consider the consumption of food is generally in proportion to the size of the animal; and with respect to rearing, such food and shelter should be provided as are calculated to promote early maturity."

There is no way in which landowners, especially in the west of Somerset and North Devon, can more effectually promote their own and their tenants' interest than by going to a little expense to improve the quality of the breed in their own neighbourhood. It may become the chief source of profit to the hill-farmer to breed steers and heifers, and to the arable-farmer to fatten them, and the more widely good animals are diffused the better chance there is of the breed not going down again.

The mongrel character of the Marsh dairy-cow, and her good qualities as a milker, will be noticed; there are some good long-horn dairies near Frome, especially one belonging to Mr. Coles of Rodden. Mr. Blandford also, near Taunton, has some cows of this breed, but he does not intend to keep them; he has also some Ayrshires. A herd of Herefords is kept by Mr. Cradock, of Lyppiat, not far from Frome, scarcely to be surpassed by any in their native county, but they are too high-bred to be favourites in the dairy. Mr. Feever, of Stoney Littleton, has been very successful with the same breed; there is also a fine herd of Herefords near Bridgewater, belonging to Mr. Culverwell. Several attempts have been made to introduce short-horns, but, with the exception of one fine herd belonging to Mr. Risdon, near Dunster, they find little favour in the west of the county. In the east Mr. Miles and others keep them for feeding purposes, and some dairy-farmers, who have good buildings, approve of them; but they must live at a better table and have better lodgings than most tenants can offer them at present.

Sheep.—It has hitherto been considered that there could not be a better sheep for the purpose of the farmers of the rich lands than the improved Bampton crossed with Leicester; the supply of rams has been drawn chiefly from the Wippells and other ram-breeders near Exeter. The Dorset breed of sheep (a horned breed, larger than the Porlock) has of late years been gaining ground, having proved in the hands of Mr. Danger, Mr. Combe, Mr. Culverwell, and others, to be capable of very high feeding qualities as well as of producing early lambs, for which it has long

been famous. Mr. Salter, of Combe, near Crewkerne, has returned to this breed after trying Southdowns for five years with a flock drawn from the best Sussex breeders. His ewes command very high prices.

Pigs.—The pigs of the county have been greatly improved of late years; the lean, long-legged animal is rarely now seen even in the sty of the cottager. The improved Essex and Berkshire, I think, are the most approved for general purposes. Some of Prince Albert's and Lord Radnor's blood has been introduced near Taunton, and some large Oxfordshires near Wellington.

It must not be forgotten that Somerset possesses one of the purest breeds of the native English horse, the Exmoor pony; the breed is carefully kept up by Sir Thomas Acland, on Winsford Hill. Very fine cart-horses are bred in the Marsh: colts fetch from 25*l.* to 35*l.* at the Bridgewater fairs.

"*The Quality of the Soil on the Moor Lands, and the advisability of bringing them into Cultivation, with any instances of success in such Improvements.*"

The word Moor, in Somersetshire, is associated almost invariably with wet, boggy land, such as Sedgemoor, in the Bridgewater Level, or Exmoor, which is famous for its bogs. It is, however, understood that this thesis refers to what we call "hill" or "common," *i. e.*, unenclosed high land, such as the moors in Scotland.

The soils on the moor-lands, understanding the term as now explained, have already been referred to two general classes —the stone-rush and the rag; and it has been stated that the latter is the most favourable to grass, and therefore the most valuable; for none of the moors can be said to be good cornland, on account of their climate. Taking, however, some of the principal groups of moor, it may be said that Heydon and Maundown, west of Wiveliscombe, Dunkerry, and part of the Porlock Hills belong to the more barren class; and that Brendon Hill, Hawkridge, part of Winsford Hill, Grabbist, and other hills near the north coast, east of Porlock, and some of the small commons near it, have good soil on the rag, and are improvable.

But within the compass of this Essay it is impossible to estimate the value of particular moors with any degree of accuracy, and it is equally impossible, without particulars, to make any general statement conducive to a practical result.

Some of the commons appear to have been in past times enclosed and abandoned, either because the soil was exhausted or the cultivation unprofitable. The surface of others has been pared off for fuel. Some which have a deep soil lie to the north, and are chilly and wet; others, which lie to the south, have not an inch of soil on the stones. On the other hand, there are moors

on which the heather has been cherished as a covert for black game, which show decided symptoms of natural capability. Either the heath grows high, or its purple hue is chequered with green ferns, or the grass has grown well on patches, which the commoner has burned to gain food for his sheep. But still many questions remain to be answered in detail in each case (assuming the soil to have some value), such as the following:—What will be the extent of fence to be made to enclose the ground? or of road to bring lime? or of channel to bring water for meadow? And, is the water good or bad? and will the channel hold water without clay? and is there clay near? These and many other questions must be answered before the cost of cultivation can be reduced to such an estimate as to enable the owner of property to calculate how far the outlay will exceed or fall short of the probable return, after due corrections for climate and bad seasons.

It must also be considered that many of the most favourable spots have been preoccupied, especially the combes* and valleys in which the warm springs and shelter are to be found.

It may, therefore, fulfil the conditions required by the Council if this Essay states what the writer conceives to be the most practical and advisable way to deal with these moors, in cases where there is a reasonable hope of bringing them into cultivation with profit. The moors generally occupy only the upper part of long lines of hill, rarely exceeding a mile in width, the intervening glens being occupied either by oak coppice, water-meadows, or breeding farms. The cases in which the whole valley is in a state of nature are the exception. The first step seems to be to endeavour, as opportunity serves, to take care that the farms adjoining the moors are in the hands of men capable of carrying on improvements, and let on such terms as may induce them to make the attempt. When a tenant has shown forethought and skill in improving what is within his fences, and the land seems to respond to his efforts, a new band of fields might be added to his farm. But expense would be saved if advantage were taken of any opportunity for running boundary fences across particular lines (as from A to B, or C to D, on the annexed plan), and the sheep of certain farms might be kept within bounds and free from the scab, the plague of the hills. By burning, liming, and other means the surface within these lines might be improved, and the land be prepared by degrees.

Measures tending in this direction have been in quiet progress for some time; and a foundation has been laid for further improvement by a gradual elevation of the habits of the small tenantry, without sudden changes. It is within the writer's

* Combe (Welsh, Cwm) is the west-country word for a narrow dell or sloping valley on the side of a hill.

knowledge, that, about a year ago, three farms within sight of Dunkery Beacon were let at a considerable advance of rent to men of capital, and that a large outlay has been incurred in the improvement of their buildings and in the employment of labour on the land; and that out of a body of old tenants, who thirty years ago used to be constantly in arrear, and were more knowing in catching hares than in breeding stock, three other men came to their landlord with cheerful faces, not to ask for "a 'batement of rent," but for an extension of their land, being ready to show that they had improved the cultivation of their original holdings.

The range of the Black Cock is, moreover, being rapidly diminished by Inclosure Acts. During the ten years 1839-49, powers have been obtained for the enclosing of about 8400 acres in Somersetshire, including 2500 acres in Taunton Deane; of the remaining 6700 acres nearly 5000 are in the western hill country, viz., 533 on Brendon and Heddon hills, 776 on Winsford and Dulverton hills, and 3634 on Exford common, and others adjacent to Dunkery Beacon. The consequent making of new roads, the first requisite in the improvement of hill-farming, gave employment to all the surplus population of Exford during the trying winter of 1848.

Among the cases of success in the actual improvement of moorland, Mr. Roals' farm on Brendon Hill stands alone perhaps as an instance of an integral farm reclaimed from the wilds. When he talked of cultivating the moor thirty years ago, he was looked upon as a madman, but he had the talent to perceive the possibility of carrying the catch-meadow system higher than it had ever been carried before; not to mention the great command of peat-ashes which the adjoining commons would give him.

This farm is 1000 feet above the level of the sea, and includes about 240 acres of arable land, and 60 meadow and pasture. I there saw a rick of hay, about 21 tons, cut from a catch-meadow of 14 acres, which, thirty years ago, was a moor. One of the most instructive points on this farm is the useful accommodation which Mr. Roals has put up at a cheap rate. He has a lambing-yard 100 feet square, with sheds, which cost 100*l.*, and a feeding-house for 10 bullocks, which cost under 10*l.*, and has stood for 25 years with a little thatching once in three years.

As an instance of the more gradual process of creeping up the hill side, may be mentioned Cloutisham farm, at an elevation of from 700 to 1000 feet, on Dunkery, which was formerly let as summering-ground to a vale farmer, producing a very small rent. It was taken in hand by the owner about ten years ago. The old pastures, the lowest ground, have been improved; water-meadows have been made above them; and between the water-meadows and the open hill good crops of turnips and oats are produced on

fields which used to be furze-brakes. A piece of permanent pasture is being laid down after turnips at a very high elevation, in imitation of Mr. Blake. It is now an excellent breeding farm; the summer grass fattens oxen and sheep, and a good basis has been laid for further encroachments on the hill-side in any direction in which the return will pay for the outlay in fences.

Hill Fences.—The cheapest fence against the moor is a *single*

ditch wall. It consists of a stone wall of 5½ or 6 feet, built in a ditch with the earth banked up against it on the inside. It must have a strong projecting coping-stone to turn the Exmoor sheep: for they will jump any common bank or wall. The expense of this fence is, per perch (16½ feet), about—

	s.	d.
For labour (sinking foundation, &c.) . . .	1	6
,, ,, (walling)	2	6
3 tons of stone, quarrying and carriage according to distance	3	8
	7	8

This fence gives no shelter on the inside, and the sheep can jump out to the hill from the enclosure. The fence which gives complete shelter is a *double ditch wall,* 5½ feet high, with a

beech hedge on the top. It consists of 4¼ feet of stone, 1¼ feet of turf-sod, 5 or 6 feet wide at the bottom, with a sloped ditch on each side, and two lines of wattling on the top (called vrith or

wreathing), between which the beech-plants are nursed up. Mr. Smith, on Exmoor, is trying posts with iron hoop-bands, with a view of turning the sheep more completely; but the natives say this will not answer, for the young beech plants must have "succour," that is shelter, themselves, or they will not grow.

This fence costs—

	s.	d.
For labour (sinking foundation, walling, wreathing, and planting)	4	0
20 withy pitches	1	8
1 seam of wreathing	1	6
Half a hundred beech plants	0	9
Quarrying 4 tons of stone and carriage, about .	4	8
	12	7

A *double turf-hedge* to divide fields within a larger enclosure requires no carrying of stone, and the labour costs 1*s*. less than in the case of the walls, while the wreathing, planting, &c. cost as much.

Supposing an advance to be made up the hill by the addition of a new line of ten-acre fields to an existing enclosure (see plan),

there will be required for each field, taking prices rather lower than what they have been given above:—

	£.	s.	d.
40 perches of double-ditch stone wall with beech hedge, against the hill, at 8*s*. per perch for labour	16	0	0
Quarrying and carriage of stone—40 perches at 4*s*.	8	0	0
40 perches of turf wall and hedge to divide the fields, at 7*s*. per perch	14	0	0
Two gates, posts, fixing, &c.	2	0	0
	40	0	0

Exmoor.—The enclosure of this moor has excited so much interest, and its circumstances are so peculiar, that it deserves a separate notice. The Forest of Exmoor consists of about 20,000 acres. Its elevation varies from 1000 to 1200 feet. Its surface is in the form of undulating table-land, furrowed out by deep stream valleys. It falls from west to east, the prevailing winds being from the westward. Previous to 1818 it was held by Sir Thomas Acland on lease from the Crown. About 500 Exmoor ponies had the run of the forest, and large numbers of sheep were taken in for summering from the surrounding farmers. In 1818 it was sold by the Crown to J. Knight, Esq., of Wolverley Hall, Worcestershire, who surrounded it with a wall, and for many years retained the whole in his own occupation. He bred a large number of Highland Scots cattle—pure, as well as crossed with shorthorns and Herefords. They have thriven very well, and it is much to be regretted that the breed has come to an end on the moor. He also bred good horses and a flock of excellent Cheviot sheep.

Since 1841 the forest has been chiefly under the management of Mr. Frederic Knight, son of the above-named gentleman, who has been endeavouring gradually to bring it more into the position of ordinary landed property. Fifteen farm-houses and buildings have been erected, and about 40 cottages; 22 or 23 miles of road, 140 miles of fencing (wall or bank) have been made, and more are now in progress. The surface of the moor is covered almost over its whole extent with a moist grassy clothing, the character of the herbage varying with the nature of the soil and the state of the drainage. There are three principal kinds of soil :—

1. The red, brown, and generally the drier soils. These are the best and the cheapest to cultivate; they require only to be pared, burnt, and limed, and will bear the finest root-crops.

2. The moderately black, or peaty soils. These soils have under them a thin crust, locally called a pan, impervious to water, which must be broken through: this is easily effected by subsoiling.

3. Deep, black, boggy soils, owing to the accumulation of water at particular spots. These require deep draining to bring them into cultivation.

Over the whole there is considerable depth of soil and vegetable matter, which, when relieved of the water and subjected to the action of lime, is extremely favourable to vegetation.

The difficulty of the forest is climate—wind and rain, rather than frost and snow, prevail in winter. The summers, with the exception of occasional driving showers and mists, are often fine.

Unfortunately, much time was lost before effectual steps were

taken to construct those outworks which are necessary to enable the farmer to wage war with climate.

The experience of the hill country points to plantations and lofty beech hedges (each of which is a plantation in itself) as the only effectual means of providing what the hill countryman expressively calls "succour."

This deficiency is now, however, in course of being supplied; good hedges are rising, and the farm-houses are being surrounded with plantations, which will give them an air of comfort and respectability. Once furnished with "succour," the natural capabilities of the forest may be turned to account. These are, a soil and climate favourable for the growth of grass and of root crops; for the breeding and rearing of stock; natural springs and convenient slopes for water-meadows; ample streams for water-power, and lime close at hand. It is not a climate for the ripening of grain; though in a fine autumn, after a warm summer, large crops of oats may be harvested. But green crops, grass, young stock, and dairy produce, must be the reliance of the Exmoor farmer.

Mr. F. Knight has been fortunate in obtaining the services of Mr. Robert Smith, of Lincolnshire, the author of the Prize Essays 'On the Management of Sheep' and 'Grass,' as his resident agent. Since Mr. Smith's agency commenced (Lady-day, 1848) he has let 4000 acres to highly respectable tenants, in addition to land previously occupied. It is a real pleasure to witness the success of manly and enterprising farmers on new ground. Mr. Hannam, from the neighbourhood of Wincanton, has a herd of yearlings, crossed between Devon and Hereford, in as beautiful condition as any one could wish to see; and makes very good cheese, like Cheddar. Excellent Stilton cheese is made on the north side of the moor by Mr. Meadows, from Leicestershire. But one of the most remarkable sights on the moor in November last was a field of 60 acres of purple-topped turnips, which, after a tour through Lincolnshire and Norfolk, I thought were the finest I had seen within the year. They were on Horsen farm, rented by Mr. Searson, who is still in the occupation of a large farm near Market-Deeping, in Lincolnshire, and wishes to have two strings to his bow in these times; and if corn fail him, to fall back on roots and stock. 700 sheep, a cross between Exmoor and Southdown, were folded on these turnips, and made the hill look like Lincoln Heath. On the pasture outside was a breeding flock of Exmoor ewes with a Leicester ram, intended to drop their lambs as late as April. The turnips were grown on newly-broken ground dressed with lime. Mr. Searson's resident bailiff, a Lincolnshire man, was not born to be a believer in the virtues of lime, so he played a trick on his employer, and omitted it in

several patches; but he had the candour to show the places, bearing about one-fifth of the average of the rest of the crop, with great glee acknowledging his own conversion.

The value of lime may be curiously illustrated by another field which Mr. Matthews, the tenant, had breast-ploughed and limed with 120 bushels per acre. A crop of white turnips had been taken and fed off. Next season a crop of Swedes (called locally "copper tops") was drilled on the flat at 20 inches apart. The object of these two root-crops is to eradicate the native grasses. A crop of oats will succeed, followed by seeds, and a sweet herbage will last for several years. Just below this field the water was breaking out from the ditch and gateway. It was merely finding its own way over the sward, but it made half an acre look like a water-meadow, while the common surface-water breeds coarse sedge and rushes. This shows clearly that a well-limed field of turnips on the top of a hill has more work to do for the farmer besides keeping his sheep, inasmuch as its subsoil-water may be conveyed over the old pasture below, and turn it into meadow.

Mr. Smith has invested his own capital in a large farm, the management of which he shall explain in his own words:—

"The system adopted upon my own farm is,—first to pare the land by manual or horse-labour, according to circumstances; then to burn the furrow as it lies upon the surface, thereby not only charring the sod, but the land upon which it lies, as also destroying all insects, seeds, &c.; the ashes are then ploughed in as thinly as possible, and from 2½ to 3 tons of lime per acre spread upon the surface to decompose the vegetable matter; after which the whole is mixed by the harrow, &c., and the seed drilled in rows upon the flat, twenty-one inches apart, the cost per acre being as under:—

	£.	s.	d.
" Paring, if by manual labour	0	12	0
Burning upon the land	0	1	6
Ploughing, harrowing, &c. . . .	0	8	6
Lime and labour	2	10	0
	£3	12	0

Should the furrows have to be thrown in heaps for burning, and the ashes spread, the cost will be 3*s.* 6*d.* per acre more.

"The weight of swedish turnips upon these lands averaged 25 tons per acre, thus being grown (including rent, rates we have none) at 3*s.* 3*d.* per ton, and the land prepared for after-crops.

"On the peaty soils requiring to be subsoiled, I find it best to prepare the land in the autumn for the succeeding spring, by paring and burning upon the land, half-plough the land into ridges, and subsoil between them, the subsoil-plough following two teams every other furrow. By this plan the ashes are preserved for early use and the land left perfectly dry and exposed to the winter frosts. This is succeeded by a cross-ploughing in the spring, and the whole is complete for the harrowings, sowing, &c., at an early period. The cost will stand thus:—

	£.	s.	d.
"Paring and burning	0	13	6
Half-ploughing into narrow ridges .	0	4	0
Subsoiling every other furrow . .	0	8	0
Cross-ploughing.	0	6	6
Harrowing, &c.	0	3	6
Lime and Labour	2	10	0
	£3	17	6

"This process may be followed by any crop, either corn or roots.

"My corn being too strong and flaggy in the past year. I have drawn the whole of my turnips off the land this season, which I am now consuming with 120 head of cattle, 50 pigs, and 20 horses. I may add that I have 15 acres of rape, which I intend to stand for a crop of seed upon the Lincolnshire plan.

"*Course of Cropping.*—As I consider this property more favourable to the growth of roots and grass than that of corn, I purpose adopting the *six*-field course, thereby having half the farm under tillage and half under grass, which will range:—1, roots; 2, corn; 3—5, three years grass; 6, corn.

"Having an abundance of good ashes for the root crops, the whole of the manure raised upon the farm will be applied to the grass lands.

"By this system (in conjunction with some forest land at a cheap rate) an abundance of stock may be kept both winter and summer; and as I have every facility for water-power, I purpose cutting up the majority of my corn crops for cattle, thereby save the cartage of the corn to market, raise a good supply of farm-yard manure, and let the general produce of the farm be transformed into meat, and walk to market on the frames of the animals, or be exported in the shape of cheese, butter, &c.

"*Draining* is but little required, except where springs occur, subsoiling being the chief operation on peaty soils.

"The bog you noticed leading to my house is now perfectly cured by deep drains. The land during the last summer, after draining, was ploughed by means of the horses walking outside the furrow; it was then left roughly exposed to the elements. During the present winter it has been dug over, at the same time observing to level the land.

"In the spring I intend to fork it over, and to apply 3 tons of lime per acre previous to setting the land with potatoes. Some parts of this bog are from 6 to 7 feet deep, and would afford an almost unlimited supply of manure for top-dressing the dry lands; and by an admixture of lime and salt would be perfect."

Mr. Smith deserves the credit of being the first to introduce into the far west the Lincolnshire principle of compensation to tenants for durable improvements made at their own expense, from which they have not had time to reap a profitable return.

Mr. Knight's arrangement with the Exmoor tenants is as follows:—Leases are given for twenty years, divided into periods of four years, with rents commencing at very low sums, and gradually rising at the end of each period of four years, the lessee having the power of determining his lease at the expiration of eight or sixteen years, on giving twelve months' notice.

In order to encourage the tenant to farm in the highest possible manner, it is provided that, on the fulfilment of certain

conditions, the tenant shall be entitled, in the event of his quitting the farm at any of the periods agreed on, to receive back a portion of the expense which he has incurred in durable improvements.

In order to acquire a title to this repayment the tenant must give an account each year of the outlay which he proposes to make in durable improvements, and must obtain the owner's sanction in writing, such sanction being necessary in order to his being entitled to the allowance. The allowance will then be calculated on the supposition of the tenant being repaid his outlay with a profit, in the number of years set opposite to each improvement, as follows:—

1. Draining	8 to 14 years.
2. Lime	4 years.
3. Bones	3 ,,
4. Subsoiling peat lands .	4 ,,
5. New fences . . .	14 ,,
6. Water-meadows . .	4 to 8 years.
7. Buildings	20 years.

The written consent of the owner or his agent to the proposed outlay before it is incurred, and his signature affixed to the bill of disbursements after the work is done, is the tenant's voucher. The non-payment of rent for six months, or breach of covenants, forfeits the claim to compensation. Disputes to be settled by two referees (or their umpire, whom the referees are to nominate before proceeding to business).

It will be observed that this arrangement gives full security for the investment of capital to a responsible tenant, at the same time that it protects the landlord against a man of straw. The compensation allowances are not claimable unless rent has been paid, covenants kept, and the amount of outlay, of which a portion is to be repayable, sanctioned by the owner.

While this Report has been in progress the news of the death of Mr. Knight has reached England from Rome, where he has resided for several years; but it is said that to the end of his life the remembrance of this wild moor was more pleasing to him than all the charms of the Campagna. He will long be remembered as the first person who had the spirit to commence a great agricultural work which Mr. Billingsley foretold fifty years ago in the following words:—

"A very large proportion of the whole (Exmoor) needs but the spirit and the fortune of some one or more of our wealthy gentlemen of England, whose attention, if turned this way, sanctioned by the royal proprietor, would render the forest of Exmoor in a few years as fair a prospect as the surrounding country, and not a useless and void space in the map of the county of Somerset."—p. 288.

It is remarkable that Mr. Billingsley, in foreseeing the possibility of cultivating the moor, should have pointed out at the

same time the two great desiderata for success, namely, plantations and the reasonable encouragement of an industrious population. On the page following that from which the above quotation is extracted he says:—

> "Excepting a few willows and thorns by the sides of the rivulets, not a tree or a bush out of Simonsbath estate is to be seen on the whole forest, but plantations of most kinds need no more shelter nor better soil than is met with here. . . . Let there be a small town or village erected near the middle, suppose by Simonsbath, which should form proper residences for artificers and husbandmen employed in building farm-houses and enclosing many a comfortable estate around them."—pp. 287-289.

The difficulty of providing for the moral well-being of such a population, usually attendant upon new settlements before land has begun to yield a profitable return, is removed in this case by a provision in the Act of Parliament (under which the moor was enclosed) for the building and endowment of a church when it shall be required.

There are doubtless many difficulties in this, as in all great undertakings, and more than lookers-on are willing to allow. The present proprietor is in a position not of his own choosing, but he wants neither the energy nor the will to do his duty in it, and to bring the forest into a condition which an English gentleman may look upon with well-grounded satisfaction.

The Quantock Hills.—This range being in a more civilized part of the world than the other groups which have been referred to, approximates in the character of its cultivation to that of the Taunton and Bridgewater district, with which, in respect to markets and ordinary business, it is closely connected. The steep escarpment on its western face is in great part occupied by woods, plantations, and gentlemen's residences. The eastern slope is more gradual, intersected by the beautiful valleys of the Seven Wells, and Hunter's Combe, the classic ground of Wordsworth and Coleridge, in the early days which they spent at Stowey and Alfoxton.

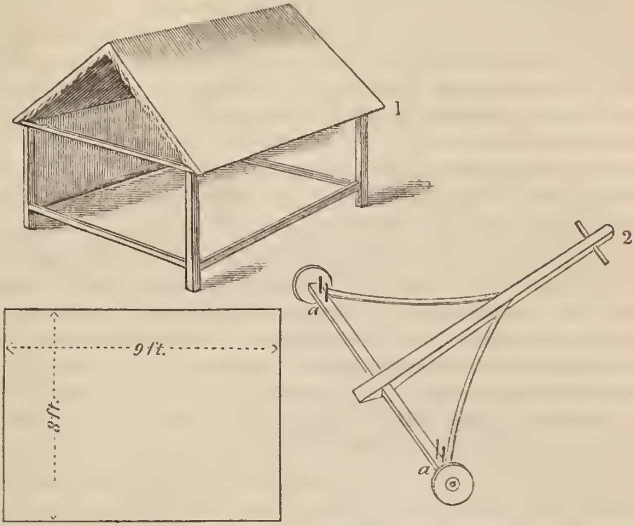
The farms on this hill are generally larger than those which we find in the extreme west; and some are very well managed. There is one which presents especial points of interest. The farm of Hunstile, skirting the woods of Halswell, the seat of Colonel Tynte, on the eastern slope of the hill, has been in the occupation of Mr. Danger or his family for upwards of a century. It would puzzle a Norfolk farmer to cultivate a farm, in riding over which one must needs dismount to keep the saddle in its place, so steep are the sides of the combes; and yet there is farming here, of which, for neatness and practical efficiency, the men of the eastern counties would not be ashamed. The secret lies in this—the occupier likes his land, as well as his horse,

"to be above its work." I observed some very fine crops on a high field, which not many years ago was a furze-brake, and on inquiry I learned that they had been produced by growing two green crops in succession fed off with sheep. Mr. Danger has, on full consideration, decided on adopting for his high land a five-field rotation:—1. Wheat; 2. Turnips; 3. Barley; 4 and 5. Grass for two years. This decision is taken after trying the four-field system, partly with reference to the situation of the farm and partly with reference to the circumstances of the present times, in order to reduce the outgoings. In any field in which the grass may happen to fail in the second year, rape will be cultivated. All the green crops are put sufficiently wide in the drills to admit of the use of the horsehoe. The plants are always singled out by hand—leaving common turnips 6 inches, swedes 10 inches apart; the work is done by children. Mr. Danger attaches great importance to this plan, as the turnips often require hoeing when the men are wanted in the harvest-field; and great mischief would be done if the hoeing were delayed. One woman looks after eight or ten children; and in point of regularity, Mr. Danger says, they will beat the best hoers in the county; and they do it at less cost. Certainly the neatness of his turnip-fields confirms this statement.

Mr. Danger and several of his neighbours keep Dorset horned flocks. But Mr. Danger is not content to follow the practice of the south of the county, by working his sheep hard in folding and selling them lean. He fats his own wethers, and, by keeping them well through the winter, and giving them corn for two months, brings them to 20 lb. per quarter at 16 months old. He does not consider that folding the sheep on the land for ten or twelve hours with nothing to eat, is good farming. They run on the pasture by day, and are folded at night on vetches, rape, or some other green crop. He has adopted an excellent plan to give shelter to his sheep. It has been matured by degrees after several trials, and answers thoroughly. It may, therefore, be worth the attention of other hill farmers to learn the results of Mr. Danger's experience without his trouble. He has a number of moveable sheds (1) of simple construction, about 9 feet by 8 feet or 9 feet square, and covered with thatch. Instead of wheels to the sheds, which were found to clog, a truck (2) is used, on which two men can easily place the shed and move it: several of these sheds are placed quite close together; and in cold or rough weather the sheep, when lying down, are always to be found under them.

It deserves consideration whether the chief objects aimed at in the house-feeding of sheep are not attained on this plan without the labour of carting home the roots and carting back the manure

to the field: on the other hand, it is open to the objection of distributing the manure unevenly.



a, Iron pins to keep the shed steady in its place.

Middle District.

The Middle District, which has been described as the physical basin of the Somerset waters, flowing between its principal hill ranges, consists of four main divisions, quite distinct in their character:—

1. The red marl and sandstones in the Vale of the Tone.
2. The Bridgewater Level, lying between the Mendip and Quantock Hills.
3. The lias and clayland adjoining the Bridgewater Level on the south-east.
4. The sandy loam on the oolite surrounding the bed of lias on the east and on the south.

Vale of Taunton.

New Red Sandstone and Red Marls.—Closely connected with the West Hill country, though widely different in character, is *the Vale of the Tone*—which opens into the Bridgewater Level between Taunton and Bridgewater. This vale rests for the most part on the new red sandstone formation, which also stretches to the sea on both sides of the Quantock Hills, isolating that range by dividing it on the east from the Bridgewater Level, and on the west from the range of western hills on the Devonian formation. The rich arable lands and meadows which lie to the north of the last-named high lands along the sea-coast to the westward, are

also on the new red sandstone, including the valleys and flats about Williton, Dunster, Minehead, and the little vale of Porlock. The soil at the base of several hills, and the Vale of the Yeo, in the east of the county is similar in character. It may not be out of place to remark that the same formation passes in a continuous line from Taunton into Devonshire, and may be recognised in the rich red soil in the vales of Collumpton, Exeter, Honiton, and Crediton.

As is commonly the case on this formation, the texture of the land varies from field to field, a fact which should be taken into account in the sweeping censure of small enclosures; but, generally speaking, it may be said that the heavier soils predominate on the Blackdown side of the Vale of Taunton, which is bordered by the lias, and also on the confines of the marsh-land near the banks of the Parret, at Durston, and North Petherton, while the land which lies on the slope of the Brendon and Quantock hills is of a more stony and sandy character. If a line be drawn from the Wellington Pillar, passing a little to the east of Wellington and Milverton, and between the parishes of Halse and Heathfield, and thence to Cothelstone Beacon, the prevailing character of the land to the west of that line will be a deep sandy soil or a stonebrash upon a clay and marl subsoil well adapted to the growth of turnips. On the east of that line, although the soil will grow very good turnips and mangold-wurzel, it is not so favourable for consuming them on the land.

The larger farms on the best land in this district average from 200 to 220 acres, in the proportion of about three-quarters arable to one-quarter pasture and orchard; but there are many farms of less than 100 acres.

The above classification of the soils of the vale has been furnished by Mr. Hancock, of Halse, who has valued more farms, perhaps, than any man in the West, and has set a good example as an arable farmer for half a century. His practice has been honourably distinguished by a large and liberal employment of labour, by the cleanness of his land, and by the extent to which he has carried the permanent improvement of the soil on his own property. He has made great improvements in his farm-buildings, removed a number of useless hedges, and carried marl on some arable lands resting on a hungry gravel, on grass-land, and on a deep peaty soil which had been occupied by old copses, in each case with a good result. Still it may be a question whether the result has been commensurate with the cost of applying so bulky a fertilizer.*

* Adjoining Mr. Hancock's land is a farm belonging to Lord Ashburton, occupied by Mr. Hibberd, whose manufactory of bacon surpasses, for practical efficiency, anything which I had seen in that line when I sent in my Report.

I should wish here to acknowledge the assistance which I have received from my friend Mr. Henry Paramore, of Park Estate, in the parish of North Petherton. I much regret that, owing to want of space, I am compelled to omit the detail of the system pursued on that estate, which would have been a good sample of the best farming in the neighbourhood, and an instructive illustration of the benefits resulting from the investment of fresh capital in the soil. It may be stated generally that the estate, comprising 1300 acres in a ring-fence and including four farms, was purchased about twenty years ago by a gentleman who wished to invest money in land. Before he bought it, it had been for many years in one family, between whom and the tenants, Mr. Paramore says, the understanding was as good as a lease; and yet, notwithstanding this, the ordinary course of cropping was then wheat, barley, grass, repeated over and over again, without fallows or green crops, except a few stubble turnips on some of the dry soils; for the wetness of the soil generally prevented the adoption of an improved system; pipe-draining had not then come into fashion; and the buildings, as well as the estate, had descended from old times.

"In 1845 long leases were granted. Since then, the greater part of the wet land has been effectually 'thorough drained' by the West of England Land-Draining Company, at a cost to the landlord of about 5*l.* per acre, the tenants paying 5 per cent. per annum interest for such outlay. Cottages and other buildings have been erected.

'These improvements by the landlord have enabled the tenants to establish the four-course system of husbandry, and have induced a considerable outlay on their parts, in clearing off numerous old pollards and worthless trees, levelling many of the old double banks (on one farm alone nearly three miles have been levelled), and substituting, where required, thorn fences planted in single rows six inches apart, in the purchase of the newest and most approved implements, investing more capital in the purchase of stock to consume the green crops, in subsoiling the drained fields, in newly laying out the meadow-lands for irrigation (at a cost of about 1*l.* per acre), and in bringing into good tillage by breaking up and well manuring with quick-lime (about 30 hogsheads per acre) old and inferior pasture-lands.

. . . . .

"About 25*s.* per acre is expended per annum for labour, exclusive of the cost of the additional improvements which have been made."

On some heavy soils the following rotation is adopted:—

1. Beans on the layer. 2. Winter tares fed with sheep, followed by rape fed with sheep. 4. Wheat. 5. Swedes, turnips, and mangold, and a few potatoes. 6. Barley, seeded out with clover and other grass seeds. 7. Clover once mowed, afterwards fed with sheep for two years. The whole of the farmyard manure is applied to the root-crop, burnt ashes with small quantities of guano and superphosphate are drilled with the seed, the dung having been previously ploughed in.

Mr. Danger, of Turnstile, the principal part of whose farm has

been described in our hilly district, has some heavy red land on which he adopts a different course:—1. Beans; 2. Wheat; 3. Vetches; 4. Barley; and 5. Grass. The peculiarity in this course is the barley after vetches. Before this plan was adopted the land was unfit for barley. It has, since the change, not only grown good crops, but grain of superior quality. Each crop is grown only once in five years, and the manure being put on the clover layer before beans, there is little chance of injury from pouching the ground.

Well managed farms are to be found here and there upon the red soil in the vales from Bridgewater and Taunton to Minehead, especially about Williton and Bishop's Lydeard, Nether Stowey and Cannington, and also near Wellington, to the westward of Taunton. The management of these farms approximates, except on heavy land, to the four-course system. But the general average of farming, even in this district, cannot be stated to be high, nor is the produce of the soil, taken over its whole extent, nearly what it might be.

The General Drainage of the Bridgewater and other Levels, and the improvement yet required in the outfalls.

The Bridgewater Level (understanding by that term the portion of the Somerset basin which lies between the Mendip Hills and Quantock Hills) may be described, in a general way, as an irregular parallelogram, averaging about 16 miles in length from the sea to the south-east, and about 14 miles in breadth between the two hill ranges; containing therefore above 200 square miles. It is divided into two parts by Polden Hill. The division which lies between Polden Hill and the Mendips is commonly called *the Marsh;* or, more strictly speaking, consists of two portions, the *Turbary Moor*, between Polden Hill and Wedmore, and *South Marsh*, including all the grassland to the south-west of the Mendips. The other division of this district, lying to the south-west of Polden Hill, includes *King's Sedgemoor* and a number of smaller moors, which are to a great extent under arable cultivation, and also some of the richest grazing lands in the county.

There can be little doubt that the whole district was at one time an arm of the sea. It is supposed by geologists that at some depth below the surface there is a basin of lias upon which rests a primeval accumulation of vegetable matter, subsequently covered with an alluvial deposit. This again is covered in parts by a more recent growth of vegetable matter, which has never been permanently under water, and therefore, when left in its natural state, is still a peat or turf moor.

Some of these peat-bogs are of immense depth; the clay consequently cannot be brought to the surface, as in the fens of

Lincolnshire. But the course of improvement is marked out by nature in another way. Some of the most valuable land in the Marsh consists of the primeval peat, covered with a thin stratum of alluvial deposit. In any plan for the drainage of these moors provision should therefore be made for bringing this deposit on the more recent peat-beds, regard being had to the peculiarity of the levels and the quality of the different waters.

The general surface of the Marsh and of the inland moors is below the level of high spring-tides. The level of the land falls as you recede from the sea, and from the banks of the rivers. The reason is obvious; the tidal rivers and the sea in Bridgewater Bay are heavily charged with mud; whenever an overflow takes place, the first result is, that as the stream slackens, a deposit is made, and the further the still water is from the moving stream the less mud it contains. As a consequence of the difference of levels, the interests of the owners of the land near the outfall and near the hills are placed in direct opposition; when the waters from the uplands come down upon the moors remote from the sea, the lands at the outfall feel no inconvenience; and, on the other hand, when the water stands at about a foot or two feet below the level of the inland fields, the water at the outlet of the main drains is many feet below the surface, and therefore the ditches, on which their stock depend for water to drink in summer, are in danger of being dry.

The natural drains of the district are three:—*The Axe*, which has a short course at the foot of the Mendip Hills, rising in the new red sandstone, and passing through very good land.

The Brue, which rises in a cold clay, but receives the wash of a great deal of valuable land, and passes through the Turf Moor, leaving a valuable deposit wherever it rests.

The Parret unites at Langport the water of three considerable streams: the Yeo and the Parret, which bring down a valuable silt * from the rich land about Sherborne, Yeovil, and South Petherton; and the Ile, which, although charged with valuable matter from the land near Ilminster, is deteriorated by the waters which pass over the cold clay near Blackdown.

Below Langport the Parret receives the Tone, whose red waters during floods bring down the soil of the Vale of Taunton. The Carey used to soak through King's Sedgemoor into the Parret a little below its junction with the Tone, but is now carried out into the estuary at Dunball; its waters, passing over the cold clay under Somerton, are of little value.

At what period the sea-banks were made, or the rivers confined to their present channels, lies beyond the records of history;

* An analysis of the deposits of the rivers Brue and Parret will be found under the head Manures, p. 741.

there is no tradition on the subject. But many of the manors mentioned in Domesday Book are known to this day by the same names, such as Brent Marsh, Huntspill, Burnham, Horsey, and lie in the alluvial district over which the sea would now flow were it not for the sea-walls and river-banks.

Management of the Water-Sewers.—The custody of the embankments and drainage has for many centuries been in the hands of Commissioners of Sewers; and before any suggestions for the improvement of the levels can be made, it is necessary to advert to their constitution and mode of proceeding.

The first Commission of Sewers for the county of Somerset is stated to have been issued in the reign of Edward I. The principal Act of Parliament on which their powers are founded is the 23 Henry VIII. c. 5. In the year 1833, Mr. Hodges carried a general Act regulating their proceedings (the 3 & 4 Will. IV. c. 22).

Sewers law has never been a very fortunate arena for the exercise of legislative skill. Every county in which there are sewers views with the greatest jealousy any attempt to overrule its own traditions by imperial authority; and, indeed, if sewers are regulated in other counties as they are in Somerset, this jealousy is not to be wondered at. Courts of Sewers are held at Wington, Axbridge, Wells, Glastonbury, Wincanton, Langport, and Bridgewater. In some of these courts the Act of 1833 is but partially, in others not at all, acted upon. Standing juries used to be, and in some levels still are, impanelled, for the purpose of viewing all the public banks and ditches, to see if they are in proper order, so as to cause no public damage. They used to levy fines in defiance of all law, but now they confine themselves to viewing their level. There is no legal power to appoint such juries, and therefore no means of compelling them to do the duty they undertake. If, however, they have viewed their level, they bring up the delinquents before the magnates of the Marsh, and then ensues a scene which, if not strictly legal, is at least highly amusing. The defaulter demurs to the right of the demand on his labour, or tries to shift it on his neighbour. If the court quashes his plea, after a certain amount of vain struggling, he is summarily convicted and called upon to submit himself to the mercy of the court. If he is humble, he is at once fined 2*s.* 6*d.*, or some other sum, according to the will of the court. If he recalcitrates, he is threatened with the awful consequences of summoning a jury of the county (the legal process authorized by the Act), which are as mysterious as the unknown results contemplated in the event of the Speaker of the House of Commons putting on his hat. In fact, the legal jury is hardly ever summoned, and the man is joked or coaxed into paying his fine.

Like other ancient institutions the Court of Sewers is said (by those who feel no inconvenience from it) to work well, and always ends with a good dinner.

By an Act of last Session (12 & 13 Vict. c. 50), introduced by Mr. Moody, one of the members for West Somerset, some useful provisions have been enacted tending to give something like order and legality to the execution of sewers law. But the general powers of the Commissioners are still deficient in one important particular, without which little advance can be made towards a general improvement of the levels, namely, a power of regulating irrigation as well as drainage.

Present State of the Levels.—The account of the state of the different levels involves too much detail for insertion in this Journal.* It may suffice here to say that although considerable improvements have taken place, there are still, in one portion only of the central basin, viz., that drained by the Parret, thousands of acres of moor or fen lands capable of the highest order of arable cultivation, which are liable to the risk of having the whole of their crops destroyed by one high flood in July. A large portion of the grass-land is of the coarsest description, and cannot be improved without an alteration in the general management of the water, and the expenditure of time and money required to keep up the present ineffectual system are very considerable.

The occupiers are so anxious for a sufficient supply of water for their stock in summer, that plans of deepening outfalls are looked upon with mistrust: on the other hand, it often happens that some farmer who has a few shillings' worth of grass left on his land at the fall of the year, is opposed to letting in the thick water, which is of great importance as a natural manure.

In time of floods a sort of feudal war is carried on between the occupiers of adjacent lands, those of the higher wishing to relieve themselves at the expense of their neighbours below. A wall or dyke was shown to me on which thirty or forty men have been obliged to mount patrol all night, for fear it should be cut through.

Much of the evil of the present state of things is owing to the neglect of the owners of land, who will not go to the expense of putting proper dams or clyses to their own ditches, by which they might provide against times of drought, and keep the water in their own ground at a sufficient level. Unfortunately in some cases the property is so much subdivided as to make it difficult to apply this remedy.

* I regret that I am obliged here to omit many particulars furnished to me by different friends, and especially by Mr. J. R. Peniston, one of the engineers employed on the Bristol and Exeter Railway, who is in possession of much important knowledge on the subject.

But the greatest evil is the want of proper means for drawing off the water, which is owing partly to natural and partly to artificial defects.

First and foremost is the smallness of the channel of the River Parret, between Langport and Boroughbridge. If sections of the channels of the Yeo, of the Ile, and of the Parret be taken above Langport, the areas of the three sections added together would cover double the area of the section of the main channel into which those rivers flow. Up this narrow channel as far as Langport flows the tide from the sea, carrying with it during the time of flood-tide all the waters of the Tone valley.

Secondly, the artificial drainage of King's Sedgemoor is very deficient. In principle, the plan of this drainage is good, with a view to the ultimate adoption of a general system, for it has diverted the downfall waters of the Cary river, which used to find their way into the Parret near Boroughbridge, and to that extent the main river is relieved. But the King's Sedgemoor Cut was not originally made large enough, and its bridges were of too small a span. Its outlet was wrongly placed in consequence of the opposition of one powerful landowner, and is not as low as it ought to be. Some improvements, however, have lately taken place. The sluice has been lowered 20 inches, and some of the bridges widened.

Plans of Improvement.—It would require a combination of engineering skill and exact local observation, neither of which I can pretend to possess, in order to decide what is the best remedy for these evils. I can only attempt to state the opinions of others, and to indicate certain principles which ought to be kept in view.

A very able Report on the state of King's Sedgemoor (exclusively considered) was drawn up by an eminent engineer, Mr. Glyn, in the year 1842. He suggested two plans: the one, to improve the outfall of the King's Sedgemoor cut, by altering the situation of the sluice so as to gain four feet more fall, and make an improved cut from Bawdrip Bridge to the sluice; the other, to turn the lower part of the present cut into a reservoir, into which the water might be pumped over a barrier by steam, the reservoir clearing itself with the ebb tide. These suggestions have reference to King's Sedgemoor alone, and make no provision for warping the land with thick water in winter.

A plan has also been laid before the Commissioners of Sewers for making a barrier against the tide, just above Bridgewater, which would imply very complicated and expensive arrangements to combine the interests of the navigation and the drainage.

Another plan has been suggested by Mr. Perrott, a yeoman who resides on his own property in the Marsh, which, if it be practicable, appears to fulfil more nearly than any other the conditions of a comprehensive measure. It is, to construct large catchwater-drains, by which the waters above Langport, on reaching a certain height, shall be diverted round the base of Ham Hill on the north, and the waters of the Tone Valley in like manner

round the south side of the moor. This plan presumes the concurrence of the landowners of King's Sedgemoor in the enlargement of a plan which their own interest already requires. It would give them in return the power of warping their own lands with the rich silt which comes down from the fertile lands about Yeovil and South Petherton; and at the same time facilities might be given for bringing up in barges the deposit which accumulates at the mouth of the Parret.

It is to be hoped that the landowners will see the importance of not leaving this magnificent district in its present state. If the principal proprietors, instead of remaining passive or timidly placing difficulties in the way of improvement, would endeavour to take the lead in influencing public opinion in the right direction, capital would find its way into this as into every other hopeful undertaking.

In dealing with the waters of this basin there are four distinct objects to be attained:—

1. To prevent sudden floods overflowing the land in summer when the crops are growing.

2. To keep water enough in the ditches for the stock to drink in dry weather.

3. To have the power of flooding the land with thick water, that is, water charged with silt from the hills in time of heavy rains.

4. To have the power of drawing off the clear water as soon as the silt has settled.

In one word, the *control over the water* at all times of the year, so as to be able to let it in on the land or to draw it off, according to circumstances, is the end to be aimed at. And the attainment of this power over the water implies an unity of management and the consent of various interests, which are very difficult to bring about.

It might be said that it would be absolutely impossible, if it were not that seeming impossibilities in this district and in a larger district in the east of England have been overcome, and that the necessity of combination for great works is more felt as information is more widely diffused.

The main principles to be borne in mind prior to the relief of any particular moor by steam or otherwise appear to be these:

To relieve the present overburdened channel of the Parret, either by enlarging it or by diverting the water which now causes it rapidly to overflow.

To aim at making the natural drains clear themselves, rather than to trust to steam.

To combine the power of flooding with that of draining.

Marsh-Farming—Grass-Lands.

The grass-lands in the marsh have to a great extent been reclaimed and apportioned in modern times; the fields are there-

fore large and well shaped. They are divided by large open ditches, which serve to drain the land in wet weather, and to supply the stock with water in summer. The main drains, which are under view of the Commissioners of Sewers, are called *rhines.* Each field is crossed by small open drains, called *gripes,* for the purpose of carrying off surface-water. I am especially indebted to Mr. Gabriel Poole, of Bridgewater, for much of the information which follows in reference to the grazing land, and to the value of the arable land in the Marsh.

The grass-lands are of three qualities:—

1st. The prime grazing-lands, which the tenant is under heavy penalties not to pasture with milch cows, and not to break up or mow.

2ndly. The dairy-lands.

3rdly. The lands which are constantly mown for hay, or which, having been over cropped in tillage, are laid down again to grass.

The value of the grazing-lands is very great. The best of these lands will fatten a bullock per acre in the summer, and winter two sheep per acre afterwards. The graziers generally "*hayne*" up the land (*i. e.* let the grass grow) at Lady-day. About May they put on the beasts in various degrees of condition, so that they can draft off some about midsummer, and sell some more about St. Matthew's fair, on the 2nd October. Those which remain go home to be finished in stalls: then some hog wethers are put on, and get nearly fat in the winter. On some lands a grazier would put about thirty bullocks, with as many couples of ewes and lambs, on forty acres. The lambs would soon get fat, and leave the ewes to "*make themselves out.*" A curious reason for not putting too many sheep with the bullocks was pointed out to me,—that if the grass is kept too short, the bullock cannot lap his tongue round the grass to feed himself to advantage. The expenses of these grazing lands are very trifling: the cattle are looked after by a "heed," who receives 9*d.* per acre: they yield a rent of about 3*l.* an acre. One of the most remarkable of these pieces of land is Horsey Slime, through which the railway passes on leaving Bridgewater for London. Pawlet Hams below, and the banks of the Parret generally, are very valuable.

A great change has taken place within the last fifty years in the occupation of grazing-land. In the days when

"Muster Guy wur a gentleman
O' Huntspill, well knawn
As a grazier, a hirch un
Wi' lands o' his awn,"

every parish in the Marsh had several wealthy proprietors who farmed their own estates, and were great graziers; but the degenerate days of mangold-wurzel and swede turnips have made

great changes in the marsh aristocracy. Many of their children have followed the higher professions, and the race no longer exists in its glory.

St. Matthew's fair is no longer what it used to be, for the owners of the finest animals take care not to go into the market when others, who must sell, bring down the price.

The best grazing-lands are now generally rented by west country farmers, living fifteen or twenty miles off, whose straw yards and breeding farms give them a great advantage over the resident grazier. Well-bred stock are generally fatted by the breeder, or, if sold lean, fetch a high price. The only remedy is to break up the inferior land in the Marsh, to farm it well, and grow good root crops. One eminent grazier, who has acted upon this plan, told me that he can fatten fifty bullocks where his father fattened ten.

The second class of grass-land, the dairy-land, is the greatest in extent; and the principal produce of the Marsh is *cheese.*

The dairy farms vary in extent from 50 to 120 acres of grass, with a small portion of arable land. There are a few larger; but a dairy of thirty cows is of a convenient size for making daily a good Cheddar cheese, of about half a cwt., or rather more in May and June. Besides these cheeses, some small ones are made, called "truckles," which probably sell in London as North Wilts cheeses. Each cow requires nearly three acres, or about one and a half acre of summer leaze, and one acre of hay and after-grass; but as some farms are managed, they consume much more. Cows, on an average, yield 3½ cwt. of cheese, and on good land nearly 4 cwt. in the course of the year. More than half of this cheese will be of the best quality, and will fetch what fifty years ago Mr. Billingsley called "the present enormous price of 6*d.* a pound;" but in fact the best cheese fetches a higher price. Three years ago 70*s.* was its current price; and some has been sold this year for 65*s.* per cwt. Say that a cow produces only 3 cwt. of cheese on three acres of land, at 50*s.* per cwt., and the price of a cwt. of cheese will be about the rent of an acre of land; and so the proverb runs, "the *pail* (*i. e.* the cheese) pays the rent." The dairyman lives on the produce of his bacon, calves, and some butter, which the poorer ones make weekly, to the great injury of their cheese, their poverty rather than their will consenting; in order that by the sale of this butter they may have a little ready money to go on with. They have also generally a few acres of land out of reach of the floods, on which they grow a little corn for their own consumption. A good deal of cider, not of the best quality, is produced, and consumed too; for the home market for cider in the Marsh is rather better than it need be.

It must be freely admitted that a prime Cheddar cheese is one of the finest articles of agricultural produce; and that a full cheese-room, exhibited by a Marsh yeoman after his rent has been paid, and all made straight, is a pleasant sight, as it is one which the farmers have always great pleasure in showing to a visitor; but, paying all due honour to the produce of the district, it must be said that there are several abatements from the satisfaction which this fine country might afford to the agriculturist.

In the first place, the women do all the work. It is true the men see the cows milked at a very early hour in the summer, and have some trouble with them in the winter, but the real hard labour falls on the women; and very active and industrious they are; but it is a sad sight to see a man standing by doing nothing, while his wife or daughter is turning many times in the day a weight of above half a cwt.

Cheese-turners used in the midlands are not in use in Somerset: the farmers who have heard of them say they would occupy too much space.

The result of the income being to so great an extent dependent on the women's labour, as might be supposed, is unfavourable to smart and active habits out of doors, where the men's labour might be well bestowed. There is a very prevalent neglect in not *keeping their ditches and gripes clear*, and when neglected they soon choke and become useless. The cows are very frequently *left out in winter as well as summer;* and their droppings are left too long before they are gathered up.

There is very little care or attention bestowed on the cultivation of root crops. Indeed, it would be correct to say that, as a general rule, they are not grown. Many say that their land is too heavy for them, which may be true if the land is not drained, or if the improved methods of managing roots on heavy lands are not adopted. The result of this neglect is, that the cows starve all the winter, and when grass begins to shoot, instead of at once making good cheese, they spend a month in picking up some flesh on their bare bones. Add to which, that from standing about on the grass all the winter, the cows so thoroughly "pound" the ground, that in summer it is in many parts as hard as a brick, and the grass does not come up till very late. Here, however, the owners of the land are more in fault than the occupiers; for the want of proper buildings in the Marsh, and, indeed, in many other parts of the county, is truly lamentable, and must engage most serious attention.

Winter grazing on his own land, or rather in his own homesteads, forms no part of the calculations of a Marsh dairy farmer; and the consequence of course is, that litter and dung are both scarce. Indeed, when one reflects on the quantity of produce

which yearly goes off the farm, every ton of cheese carrying off nearly half a cwt. of phosphates, it is truly marvellous how the fertility of these soils is kept up, unless the manure brought down in the floods is taken up by the meadow hay, and then distributed over the fields by the cattle which are foddered in the open air.

Having ventured to speak thus freely of the defects of the average dairy farming of the Marsh, I have great pleasure in referring to the improvements which are taking place, and for this purpose I must especially name the farm of Mr. Yeoman, of Dean Farm, West Cranmore, on the borders of the Mendips. My attention was first arrested by the very superior condition of his root crops in the autumn, and further inquiry confirmed the impression which they made. His practice is the reverse of all the faults above referred to. His cows are all housed in the winter, and the greatest care and economy are used in feeding them. All the straw which is placed under them is cut up by Cornes's machine, so that a great saving of litter is effected. They are fed with straw-chaff mixed with roots, cut by Moody's turnip-cutter, a particularly useful implement when chaff and roots are to be eaten together. His young stock are fed with chaff and 1 lb. of cake per day, on the Lincolnshire plan, the only instance of this practice which I have met with in Somersetshire.

By these means he is enabled greatly to reduce the amount of hay required, and to increase the number of cows. He has cultivated the Kohl Rabi, and found it succeeded very well. The seed was sown on the 1st of March; the plants transplanted in May, June, and July, at 2 feet apart each way, and in this peculiarly dry season they did not suffer at all from mildew; the roots were out in the frost, and not injured.

If any one interested in the improvement of dairy farming desires to see the importance of the root crop, and of its *careful and economical consumption,* he cannot do better than take a lesson here. Tenants who act on these principles deserve every encouragement. In such cases the breaking up of inferior grass lands is a gain to all parties, for they are improved in value to the landlord, and the demand for labour is much increased. Mr. Yeoman's premises, though he is indebted to his landlord for better accommodation than most of his neighbours possess, are not more than are absolutely required, and of plain and simple construction: the chief advantages which he possesses in the way of machinery and implements are his own work.

Peat Moors.—In the Bridgewater flat there are two kinds of peat moor; the one fibrous, which is cut out for fuel—the other loose and friable.

The Turbary Moor, on the north side of Polden Hill, lying

between that hill and Wedmore, is of the first kind. The river Brue passes through it, bringing down a valuable silt. The turf of this moor is cut out in lumps like pieces of black soap, which, after being dried in the sun, become hard and light, and make excellent fuel.

In some parts of the Burtle Moor it is cut out in this manner, to the depth of 14 or 15 feet; and for this purpose alone it is leased on terms of seven years for a payment of from 15*l.* to 25*l.* per acre. In Ashcott an acre has been so let for 50*l.*

The peat is said to grow again after it has been cut out; the fact probably is, that the lower part of the bed being in a semi-fluid state, gradually heaves up the surface under the weight of the surrounding land. It is said to grow in this way about 3 inches in 12 months.

Two methods of improving these moors have been adopted: the one deals with the bog at its natural level; the other, with the pits or basins left by the turf-cutters.

Mr. Galton, of Birmingham, has given, in vol. vi. p. 182 of the Society's Journal, an account of the improvements made on the first plan in Westhay Moor by his relative. The details, therefore, need not be repeated here. The result, as there stated, is, that by draining the land and covering it with clay brought up from the river in narrow barges along a rhine, a crop of natural Dutch clover and other good grasses has been produced; and that a rent of 400*l.* a year has been obtained in return for an outlay which, including purchase-money and expense of improvements, amounts to about 6500*l.*, not reckoning anything for the interest of the money laid out.

From an examination of the work and inquiries made on the spot, I am led to think that some abatements from this statement must be made before it can be held up as a perfect model for imitation. In the first place, the work of claying requires to be repeated from time to time, at the rate of about 100 tons per acre, once in 7 years; the cost of which, at the rate which was being paid when I saw it going on, would be a charge of about 6*s.* 8*d.* per acre per annum, or a deduction of about 100*l.* per annum from the total rental. The land is tithe-free, and the landlord pays the taxes; which, in estimating the return by the rental, must be considered. The land also being not much below the natural level, is above the reach of the fertilizing floods in winter, and in hot summers is liable to be too dry, and to cause the grass to burn. There is, however, one advantage in land treated in this manner: it is the driest and healthiest ground for wintering young stock. I was informed that 2 ten-acre pieces of this land would keep 9 cows in summer, with 15 acres in addition for hay; the rent varying from 35*s.* to 25*s.* per annum.

Not far from Mr. Galton's field is some land treated on the other plan, which is less costly, and in some respects makes a better return. After the turf-cutters have hollowed out a basin, which by their lease they ought to leave level (though this part of their contract is wont to be roughly performed), the landlord has usually to relay the surface by throwing it into bends, with a gutter between each. The first flood is then let in upon the land so prepared, and as soon as a thin layer of silt is deposited, the natural grasses spring up, and go on improving with every subsequent flood. Land so treated frequently becomes worth 40*s.* and even 50*s.* per annum in a few years: this is certainly the cheapest method, and land so reclaimed is of the best quality. It will be borne in mind also that a considerable sum will have been received for the turf before the improvement begins.

Some acres of this Turbary Moor, immediately under Polden Hill, have been brought into arable cultivation. On Mr. Warry's property near Shapwick there were this autumn some fine turnips and magnificent rape, in which the sheep were quite out of sight. Mr. Strangways has also made great improvements in the same neighbourhood. The clay of the adjoining hills might easily be laid on this land by means of a portable railway; but the lias clay is of a very doubtful character. It is feared that it might scour cattle if the land were converted into pasture. There is good red marl in Polden Hill, but I fear it is only on the opposite side.

On the south side of Polden Hill lies King's Sedgemoor, a loose, friable peat, which is for the most part under cultivation; and very bad that cultivation is. In the first place, nothing can be worse than the arrangement of the farms. An allotment in King's Sedgemoor is joined to a farmhouse perhaps three miles off on the other side of a precipitous hill; and even where this is not the case, the fields belonging to different farms are intermixed in the most inconvenient manner. Lord Ilchester has lately built a convenient little homestead well situated on the borders of the hill and the moor; and it is to be hoped this is the beginning of an extensive improvement.

The present system of management of the moor consists of breast-ploughing and burning the surface, at a cost of about 11*s.* 6*d.* per acre, and cropping the land with wheat, oats, and potatoes, or beans, till it is so foul that it will bear no more, the crops being all drawn over the hills. The land is then sown with clover, which may be fed off, but is more probably mown, the hay going the same tedious road. For the first year or two the land will produce very large crops, up to 40 or 45 bushels of wheat and to 80 bushels of oats per acre, but they are not of good quality. The quantity is very uncertain, and liable to great injury from wet seasons and floods.

Some of the larger farmers, among whom Mr. King, of Littleton, near Compton Dundon, is one of the best (though not altogether favourably situated for carrying out his plans fully), grow good crops of mangold, rape, and swedes. Mr. King buys in a large number of sheep in proportion to his acreage; he divides them into several lots, and puts 100 of them into his green crops, first to pick off what they choose, giving them at the same time a little hay and a small quantity of oats—one bushel to 100 sheep; and finds that in this way they get on very fast at a moderate expense.

The moor is extremely subject to weed. The chick-weed, elsewhere considered comparatively harmless, is here quite a plague, rising up to 8 inches thick in a fortnight. The land is also very liable to lamb's tongue and couch. For the former of these weeds there seems to be no remedy but the constant use of the horse-hoe, and for the latter a better system of cropping. Garrett's horse-hoe does not seem to have found its way into the moor yet.

The marked superiority of those parts of the moor which have received the washings of the clay and red marl from the hills may suggest to the proprietors the value which would ensue from carrying out the clay to the lands in the middle of the moor. But a thorough improvement in the drainage and the laying down of stone roads are the needful precursors of every other improvement.

North Moor and some other low peat moors are managed nearly in the same way. The moor is pared and burnt at a cost of 1*l.* per acre; rape or some other green crop is then sown; after which wheat and oats alternately for five or six years, and the same course is repeated. Sometimes extraordinary crops are grown—sometimes the whole is lost by the floods.

West Sedgemoor is chiefly used for young stock, bullocks and horses, to run in, before and after the hay, which is all drawn up over a very steep hill to distant farms. Its drainage is in a very bad state. If this moor were thoroughly drained, and divided into well-arranged farms before it begins to be racked out, it would probably make some of the finest possible arable land; the red marl is close at hand for its improvement.

There are tracts of arable land in the Marsh quite distinct in their character from the peat lands, remarkable chiefly for their extraordinary value. Mr. Poole told me of an instance of a large field let on a lease for 21 years at 5*l.* per acre. After the expiration of the lease it was let for 4*l.* 10*s.*, and after being in tillage for 30 years, it sold for 70*l.* per acre, and immediately let for 3*l.* 10*s.* per acre. There is land in Mark Moor which has been known to bear wheat for 19 consecutive years with one fallow. In Westonzoyland and some other parishes, which rise like ancient

sea-banks above the level of the moor, are lands which bear wheat, barley, and beans or potatoes in constant succession; sometimes vetches, followed by turnips; but this is a modern innovation which has made little way. The farmers on these lands trust chiefly for manure to the hay which they draw up from the Marsh, and consume in their yards. The cultivation of mangold is creeping in, and the enormous quantity of that root which the soil will bear must ere long give it a prominent place in Marsh farming. It is far from improbable that the course of agriculture in the Marsh may be in favour of breaking up grass land instead of laying down corn land; when it is considered that the gross produce of an acre of second-rate dairy land does not much exceed three or four pounds; and that certainly 35 bushels of wheat and as many tons of mangold-wurzel may be expected from skilful arable cultivation, it is quite within the mark to say that even with low prices the produce of the land may be more than double what it now is, and although the rent might not be greater, the funds available for payment of wages would be greatly increased.

Lias Formation.

Stonebrash and Clay.—On the south-east of King's Sedgemoor is a district of table-land on the lias formation.

It presents a steep escarpment to the moor, of which it forms the boundary. This boundary has all the appearance of a cliff on the sea-shore for the greater part of its length from Compton Dunden round Somerton Hill and High Ham Hill to Langport, and thence under Curry Rivell to Hatch Beauchamp, from which point it rises with a less distinct line to the Blackdown Hills.

The table-land falls away to the southward, in which direction the lias dips under the marlstone and oolite, or under the alluvial borders of the rivers which drain the basin above Langport. To the north-west it forms the heavy clays about Lydford and Alford. There are several narrow strips of lias stretching in a north-west direction towards the sea. The longest is Polden Hill, parallel to which may be traced in detached hills a line from the Pennards to Meare and Westhay, and another line from Pilton on the south of Shepton Mallet to Wedmore, Mark, and Badgworth. There is also a detached patch of lias on the coast of the Bristol Channel forming the line of cliff from Blue Anchor to the mouth of the Parret, under which river it no doubt dips till it joins Polden Hills.

A⟵⟶B

The soils on the lias fall under two general heads—a thirsty stonebrash, and a stiff clay. The stonebrash, as might be expected, is generally to be found on the tops of the hills—the clay in the valleys beneath, and especially in little hollows on the gentle

slope of the hill called "*nidons*," as in this imaginary section; the hollow above the line A B represents a "nidon."

The land on the lias presents some of the greatest difficulties to the practical agriculturist, and, unhappily, the tenants in too many cases are not provided with the best means of contending with them. Nearly the whole of the district requires draining, without which it is hopeless to attempt cultivating the clays, and the buildings are, generally speaking, quite inadequate to the requirements of the farmer who is willing to expend capital on the improvement of a soil on which skill and capital are absolutely necessary for success. There are, however, notable exceptions to this statement on some properties, and the mother of invention is giving evident tokens of her influence on others.

The obstacles to the cultivation of roots are very great, not only on the clay but also on the stonebrash, which is naturally poor and suffers extremely from dry weather. These obstacles, however, have been in some measure surmounted by means brought into notice by Mr. Huxtable, and first practically applied to this soil by Mr. Graburn, on the Butleigh estate, of which I shall give an account further on.

It is difficult to say that farmers in this district follow any system—"some one thing and some another" was the not uncommon answer to my inquiries. In fact, there is no fixed rotation; and that is one of the greatest desiderata of the district. One of the most common modes of management on the stonebrash is the following:—1. Wheat; 2. Barley or Oats; 3. Clover; 4. Wheat; 5. Winter Beans; 6. Vetches.

The corn grown on the lias is generally good in quality, but deficient in quantity. But an impression widely prevails that the cultivation of root-crops on this soil is impossible; one farmer told me that even if it were possible it would not do any good. The result of the neglect of roots is a very insufficient quantity of food for stock. The practice is to buy lambs at the Wiltshire fairs, to keep them as a working flock, and sell them "fresh" at the end of the summer for other farmers to winter on turnips. Bullocks are grazed by those who hold Marsh land, but very few are winter-fed.

It has already been mentioned that many of the farmers on these lias hills draw large supplies of straw from Sedgemoor on the north side. Some of those who occupy land farther south draw their hay in like manner from the rich grass-lands on the banks of the Ile, the fertility of which is sustained by the thick water of the floods.

Spirited attempts have been made by some of the proprietors to grapple with the natural difficulties of this soil. Among these attempts attention has especially been fixed on the farms

of F. H. Dickinson, Esq., at *King Weston*, and of the Dean of Windsor, at *Butleigh*. They have had the good fortune respectively to obtain the assistance of practical farmers who are gentlemen of education.

Mr. Dickinson's Farm.—The extent of this farm is 640 acres, of which 366 are arable and the remainder pasture of very inferior quality. The soil of the upper portion of the farm consists of thin stonebrash, whilst the lower part is deeper, being a heavy loam with a clay subsoil, and difficult to work in unfavourable weather.

Mr. Gray, who manages Mr. Dickinson's farm, has had great experience in this county, and has conciliated the confidence of his neighbours by his practical acquaintance with the wants and capabilities of their soil. The following account of some points of his management is extracted from a statement drawn up under his direction by one of his farming pupils.

"Our rotation of cropping on the stonebrash land is as follows:—

"1. Wheat. 2. Winter beans. 3. Turnips, fed off with sheep eating cake or corn. 4. Spring wheat and the land laid down to—5. Saintfoin, to remain four years.

"Or as follows:—

"1. Wheat. 2. Winter beans or winter peas. 3. Turnips. 4. Oats (barley not growing kindly). 5. Clover or vetches. 6. Wheat.

"We sow our winter peas the second week in January, and harvest them the latter part of June or very early in July; and the land is then prepared for turnips.

"We bring the heavy land to wheat as often as we can. Thus:—

"1. Wheat. 2. Vetches, fed; mustard, partly fed and the remainder partly ploughed in. 3. Wheat. 4. Mangold, highly manured. 5. Wheat. 6. Clover, fed off wheat.

"On this description of land we usually grow our mangold, which is dibbled in on ridges 27 inches apart and 14 inches in the rows. In the fall of the year the land receives a deep ploughing, another in February, and the scarifier passing through it in March produces tilth. The ridges are then struck, and about 15 loads of dung put down an acre, covered up and rolled. A man then passes down each ridge with a dibble four feet long, making a hole large enough to contain half a pint of manure, which a woman puts down with a tin cup, and a child follows placing 5 seeds or thereabout in each hole, covering the same with a portion of fine earth. Two horses and two carts are employed in conveying the manure, the ridge being struck at such a distance as that the wheels may pass down them. A boy fills the baskets out of the cart as they are emptied by the women, and the work goes on very rapidly with 6 men, 6 women, 6 children, and 2 lads.

"We planted 20 acres in the week, and the cost of labour was 8*s.* per acre. We prepare our manure some months before. The superphosphate of lime is mixed with it at the rate of 2 cwt. an acre. It consists of rotten dung and fine ashes in equal quantities finely worked together. The proportion of half a pint in a hole will take four large cart-loads of this compost per acre, each holding about 40 bushels. This method produces a rapid growth of the plant. I estimate that we grew 28 tons an acre over 30 acres this season; 20 acres of which had no other manure than

that placed by the women in the holes, but the land was in high condition.

"We keep 14 horses; these are never turned out to grass. Each horse is allowed per week $1\frac{1}{2}$ bushels of oats, $\frac{1}{2}$ bushel of split beans (the latter is taken off during the summer months), with $\frac{1}{2}$ cwt. of bran moistened and mixed with as much steamed straw-chaff as they will eat. We do not know what it is to have an unhealthy horse, and this treatment keeps them in high condition.

"The consumption of chaff being very great on the farm, it is cut by one of Cornes's engines worked by a pony 13 hands high. Our wheat-field consists of 105 acres. The quantity of seed is 8 pecks per acre before Christmas, and 9 pecks after; as we find that thin sowing does not answer on this land."

The only criticism which I will venture to make on the above statement is, to suggest a doubt whether Mr. Gray does not carry the practice of steaming chaff too far. That steaming inferior hay will improve it is undoubted, but the profit of steaming good straw is questionable.

It may be well to add in detail the actual money paid in wages for that part of the field on which the compost and superphosphate were used alone. The extent was 20 acres, which by great activity were sown in six days, the labourers being paid by day-work:—

				£.	s.	d.
2 men mixing and filling } 6 men dibbling } at 1*s*. 6*d*. per day				3	12	0
6 women putting in manure, at 6*d*. per day				0	18	0
6 children, at 4*d*.				0	12	0
2 lads, at 6*d*.				0	6	0
2 horses, at 3*s*. 6*d*.				2	2	0
				7	10	0
Which, divided by 20, gives as the cost of labour per acre				0	7	6
2 cwt. of superphosphate	£0	16	0			
4 loads of compost	1	0	0			
Say for extra labour with the above	0	4	0			
Manure				2	0	0
Total for labour and manure				2	7	6

The best commentary I can give on Mr. Gray's practice may be given in the answer of a neighbouring farmer to my question as to his own system: "We follow Mr. Gray as near as we can manage."

Adjoining the King Weston Farm is that of the Dean of Windsor, on Butleigh Hill, conducted by Mr. Graburn.

The object chiefly aimed at in the management of the Butleigh estate is to assist the tenants to farm profitably themselves. The return of the home farm is made a secondary consideration. In the first place, a Tilery has been established, in which the thinnings of the plantations are used for fuel. Many acres have been

drained under the superintendence of Mr. Parkes; the landlord undertaking the whole expense, except the haulage of the tiles. During the last winter eighty persons were at work; superfluous hedges and timber have been removed, and the Lincolnshire principle of compensation for improvements introduced into the agreements with the tenants. Relief has been given to industrious tenants by taking some of their land off their hands for a time, to clean it thoroughly and show them what it will bear if well managed. Subordinate to and in aid of these projects the aim of Mr. Graburn has been to teach two points by submitting them to the test of practice: 1. The practicability of growing roots on the stonebrash. 2. The importance and value of a regular rotation of crops. After five years' experience he can say that he has never failed of having a plant of turnips. Last year the growth of the bulb was checked by the excessive drought of the season; but in all former years he has had good crops, both of swedes and of common turnips; and, even last year, he had some good Lincolnshire purple tops, sown in July upon a stale furrow. The land was ploughed in the autumn and *not afterwards*, but scarified several times in the summer, his object being to turn the ground as little as possible, and yet to bring it to a fine tilth, and give time for the action of the sun and air. The adjoining piece was sown in August after vetches, on a fresh furrow, and the crop was very inferior.

The root-crops are always put in with superphosphate of lime, the manure being dibbled as well as the seed, on the plan which has already been explained as having been adopted last year on the King Weston farm for mangold wurzel. It was originally suggested by Mr. Huxtable, and has been practised for several years at Butleigh for root-crops generally. The compost used by Mr. Graburn consists of the silt* of the river Brue, together with some rotted dung, at the rate of 100 bushels per acre. The artificial manure has never cost 20*s*. per acre since the superphosphate has been used; when guano was used it amounted to 30*s*. per acre.

The rotation which Mr. Graburn has adopted is a five-field course:—1. Roots; 2. Barley; 3. Clover; 4. Winter beans; 5. Wheat. The winter beans have been inserted between the clover and the wheat in order to destroy the slug which is found troublesome after the clover-layers, and also to give more time for the clover roots to rot. The turnips are grown, as already explained, at a cheap rate, with compost and superphosphate; and the dung is carried out on the clovers before the bean-crop.

* The analysis of this silt is given at p. 741. I am indebted to Mr. Ralph Neville for having it made on purpose for this Report.

The principal object of this farm has been so far attained that all the tenants on the estate but one are beginning to dibble the manure, and to succeed in growing roots. I saw a very fine crop of mangold-wurzel on one of the tenants' farms, put in on this plan.

It ought to be stated in fairness to Mr. Graburn* that he has not hitherto had liberty to stock the farm to the extent which he would wish, and which his root-crops justify; in the absence of sufficient stock to consume them at home he has sold them in former years to the tenants, realizing twenty guineas per acre, at about 15*s.* per ton.

To do Mr. Graburn's plans justice they should be seen in full operation on the farm of Earl Fortescue at Castle Hill in Devonshire—750 acres, for the most part bad land, and Lord Ebrington's farm at Leary, and also at a small farm established on the scale of the ordinary North Devon tenancies, about 50 acres of land, on which all the team-work is to be done by oxen instead of horses.

The Lias Clays are extremely heavy and difficult to work. Some are very cold and unprofitable; others, especially on the confines of the marlstone and oolite, very deep and rich. Much of the arable land so situated in Martock lets for 40*s.* per acre. It is very subject to a long black grass—the worst kind of couch. I am informed by a practical farmer of great experience, who has retired from business, that after witnessing many attempts to dispense with a summer fallow once in three years, he does not believe they have been successful. It is certain that in the opinion of the neighbourhood the monotonous course of 1. Wheat; 2. Beans; 3. Fallow, reigns supreme. My veteran friend says that—"one fact is worth a volume of theory," and I regret that space cannot be allowed me to give an account of his practice in his own words, which contain much good sense, though I do not think that his account of his expenses and returns would encourage his brother farmers to sit down contented with the old practice and to reject the aids of improved machinery.

In another part of the county, on the lias, near the Bristol Channel, the old course used to be either wheat every other year with a fallow between, or wheat followed by oats or beans, and then a fallow. I am informed by an intelligent Scotch agent, Mr. King, some improvements are creeping in. One of the leading farmers adopts the following course:—

* This is now otherwise; new buildings are also in process of erection, with a view to carry into full operation the main principles on which Mr. Graburn's practice rests, viz.:—

1. House-feeding in summer.
2. The preservation of manure in an unfermented state till it is applied to the plant.

1. Wheat.
2. Vetches, fed off, the land ploughed one earth and left for the winter.
3. Ploughed twice in spring for barley.
4. Clover, fed off.
5. Land fed till June next year; a half fallow to prepare for wheat.

One of the most remarkable clay-farms is that occupied by Mr. Blandford, a tenant of Lord Portman's, at Orchard Portman, on the borders of the lias and red marl. He found it in a very foul state, and has been at great expense in cultivating roots to clean it. The land being very unfavourable for the consumption of turnips on the ground, it is his intention to adopt a system which, to me at least, has the merit of novelty. As soon as his farm is thoroughly cleaned, he means to give up the cultivation of roots as far as possible, and to make manure in his yards by consuming the produce of one-third of his farm at home in the form of pulse, oats, and barley; in addition to another third in green crops, sending to market only wheat, meat, and dairy produce. The course will be as follows:—

1. 1-3rd wheat.
2. 1-9th pulse; 1-9th winter oats; 1-9th winter barley.
3. 1-9th roots; 1-9th vetches; 1-9th clover.

It is his opinion that where the root-crops must be drawn off the land, the carriage of 90 per cent. of water for 10 per cent. of nutritious matter is too expensive, and that it will pay better and make more ammonia to consume the pulse and inferior grain with chaff, with the occasional addition of linseed or cake. It will be observed that by the adoption of this arrangement, a heavy proportion of the labour is thrown upon the autumn; but, on the other hand, it must be considered that on such lands it often happens that what is not done before winter cannot be done at all in the spring. A comparison of Mr. Blandford's three-course system on clay with Mr. Salter's three-course system on light land, mentioned at page 724, may afford some useful suggestions at the present time.

Mr. Blandford has a portable steam-engine, which he lets out to his neighbours, and is using all the appliances which tend to promote the careful and economical consumption of food and manufacture of meat, and to put his farm into high condition.

Not far from Orchard Portman is a tract of clay land, Ashill Forest, and its neighbourhood, which is in a deplorable state. Soon after it was inclosed it was racked out by over-cropping; and it all wants draining, without which nothing can be made of it.

I cannot venture to point out the practical course which ought to be taken with the worst clays in Somerset; but I have endeavoured to ascertain what is done in other places. On a deep yellow clay on the borders of Buckinghamshire and Bedfordshire, when there is no chance of a crop if the land is ploughed in spring,

it is found possible to grow a white and green crop alternately. The green crops are tares. clovers, turnips, and mangold: winter beans are sown and well hoed, with coleseed, sown at the last time of hoeing, and eaten after the beans are harvested. The roots are all drawn, but the tops both of the turnips and mangolds are partly eaten and partly trodden in by the sheep. The mangolds are found very good for the ewes when suckling their lambs, and given to them and the tegs on the grass land. A great deal of good dung is made in boxes, and is found richer than yard-dung. I saw wheat being dibbled at 6*s.* or 7*s.* per acre on this farm, in October, by which a great deal of treading was saved.

Mr. Parkinson, residing near Newark, has informed me that on a strong brick clay, red or yellow, a combination of the four-course and six-course has been found to answer, thus:—

1st year, fallow.	6th year, barley.
2nd year, barley.	7th year, seeds.
3rd year, clover.	8th year, seeds.
4th year, wheat.	9th year, beans.
5th year, fallow.	10th year, wheat.

On this plan about half the fallow land is sown with roots, all of which must be drawn off in the autumn. Bones and dung are ploughed into the land while dry in the autumn; and the seed is sown with a light dressing of guano or burnt rubbish (charred, not burned red). Swedes are grown to a weight of 16 lbs. in a bulb, where they used not to be thought of. Mr. Parkinson says, "This rotation has superseded the three-course in many instances; the working expenses are less; the land gets more rest, carries more stock, and makes a quantity of excellent manure."

The farm has been in the hands of Mr. Parkinson's family for fifty years, and always farmed for profit. The land is well drained; but subsoiling is found to be of no use, because the land is stiff, and runs together after one year.

Oolite Sands.—To the south and east of the lias and clay soils lies a soil of the most opposite character, the *rich sandy loam on the oolite.*

This soil first appears between the lias and the greensand on the sides of the hills near Chard. It then extends from Ilminster to Yeovil, and from Yeovil northwards to Castle Cary; beyond which point it appears occasionally in narrow strips and patches. It is bounded on the south by the greensand and chalk-hills, and on the east of the county it runs into the clay at the foot of the Dorsetshire hills.

There is arable land of extraordinary richness and value near Ilminster and South Petherton,* letting as high as 50*s.*

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* In South Petherton, Mr. G. Parsons grew, in 1844, such a crop of wheat as was never before known even there: 3 acres yielded 30 quarters of wheat. It was visited

per acre. About Milborne Port it is in places more exclusively sandy.

On entering this district, near Ilminster, one cannot fail to be struck with the superior appearance of the country. The fields are well laid out, with good thorn hedges, not much encumbered with trees; and those which are scattered about are so handsome that one cannot wish them away. Further on, the hedge-rows stand thicker, although they cannot be wanted for shelter.

The farming of this district was above the average of the county fifty years ago: whether it has fully kept its place in the race of improvement may be doubted. Mr. Billingsley, whose hobby was sheep-folding, was so delighted with this district, that on contemplating the entire absence of bare fallows, he exclaimed, "These are enlightened farmers!"

The characteristic features of the farming of this district appear to be now, as then, a rapid succession of crops without bare fallows, and great attention to sheep-folding, for both of which the land is particularly favourable. As an instance of the first may be mentioned the following crops, taken by one of the best farmers in Shepton Beauchamp:—

Stubble turnips, fed off in March;
Spring vetches, fed in June;
Turnips, fed in December;
And the land sown to wheat again.

Or the following, on a field of five acres after wheat, in one season:—

Clover mowed (early in June);
Ditto fed (with 100 sheep for 6 weeks);
Green-ring turnips (keep for 200 sheep for 4 weeks);
Then sown with wheat again.

After young grass or wheat they sometimes put in a crop of flax in April; take it off in July; then sow turnips, feed them off, and put in wheat.

Flax cultivation used to be very general. It has been checked of late years by a fall in the price; and no steps appear to have been taken either to reduce the cost of production or to improve the quality of the article produced. It is sown soon after March, 2 or $2\frac{1}{2}$ bushels to the acre; weeded at about 5*s.* per acre. It is drawn about midsummer, at a cost of 5*s.* After turning and spreading for the seed to ripen, the seed is stamped out. It is laid on the pasture for the process of dew-retting instead of steeping, a practice of doubtful policy, as it is said to stain the flax, and make it fit only for coarser manufactures. It is then tied up for work in the winter, when it is prepared in dozens of

by many farmers, and carefully measured afterwards. The whole farm gave 7 quarters of wheat per acre. This was good management of good land.—PH. P.

pounds at 1*s.* or 1*s.* 6*d.* per dozen: twenty dozen make a pack; and two packs with ten bushels of seed are considered a good crop. A pack of 240 lbs. was once worth nearly 20*l.*; and within a few years, 7*l.* and 8*l.*: now it will not sell for more than 4*l.* or 5*l.*

Turnips are drilled on the flat with ashes and soot, hoed and singled by hand: no horse-hoeing practised: no bones or superphosphate of lime used in the whole district, as far as I could learn.

There is certainly, even among good farmers, a short-coming in the matter of couch; and I observed that in some places, where it was taken out of the land, it was carelessly thrown into the hedges, instead of being burned to ashes and put to rot under the dung-heap. Again, there is a general prejudice against the use of superphosphate of lime; for I could not make out that it had ever been fairly tested. Mr. Burchell Peren, a very good farmer in South Petherton, says he goes down 18 inches for his manure when he wants it. He is in the habit of employing spade-labour, and turning over his fields occasionally, at a cost of 30*s.* per acre. One of his neighbours, however, remarked, "that he did not believe he could turn up guineas with a spade any more than he could with a plough."* It is difficult to believe, if phosphorus be an inorganic element, as the chemists tell us, that a large number of animals can be reared and sent off to a distance, besides the corn yearly taken off the land, and that the green crops can be maintained in full fertility without a return of phosphates from some source. It will be found that more than half a ton of bone walks off one of these farms annually for every hundred acres.†

* Professor Way has analyzed a specimen of the subsoil of a field of Mr. Peren's. The result shows the ordinary conditions of a fertile soil in possessing the alkalies, but indicates no unusual supply of phosphates. The specimen was taken from a depth of two feet near the hedge, the roots of which account for the organic matter. The great value of this soil is probably owing to its perfect mechanical texture:—

" *Subsoil from South Petherton.*

Water	2·89
Organic matter	2·93
Sand and clay insoluble in acids	84·03
Sulphate of lime	1·00
Phosphate of lime	trace
Magnesia	·21
Potash	·63
Soda	·17
Oxide of Iron and Alumina, and loss in analysis	8·14
	100·00"

† I found great difficulty in ascertaining the weight of the bones of cattle and sheep. I could not obtain the information from the butchers or from any book. At last a Somersetshire friend in the College of Surgeons, Mr. Quekett, ascertained from the sausage-makers that the bones of a short-horn bull, aged 7 years, weighed 138 lbs.;

The principal manures purchased are woollen rags, applied at the rate of 6 cwt. per acre, costing 30*s*., and lime also, at about thirty to forty hogsheads per acre, costing at the kiln 1*s*. per hogshead. As in other places one hears "Nothing like yard-muck," so here the prevailing impression is, that there is no manure like the sheepfold. Both sayings may be very true, provided that there is always enough of the article, and that the farm does not pay too dear for it. The farmers are no doubt quite right in the value they attach to the treading of the sheep's feet; but it is still to be considered that what they leave on the ground must be obtained somewhere; and that the sheep are sometimes worked hard in their function of dung-carriers, not to speak of what they drop on the road.

The ordinary practice of the small farmers with regard to sheep is to buy lambs in August, to keep them as a working-flock during the winter, on the few turnips they have, and sell them in the spring: the larger and better farmers buy them, and put them on swedes and vetches, and carry them on to the following winter. The average farms do not maintain above 100 sheep on 100 acres in this fashion, and that for a part of the year only. The superior farmers keep large breeding-flocks, and maintain, perhaps, nearly 1000 sheep on 600 acres, and twelve working oxen besides. But they are not fond of fatting off sheep; they make it their principal object to sell their ewes in lamb at Weyhill fair in October, whence they go up the country to drop their early lambs for the London spring markets. The Dorset breed, or "Somerset horns," as they are called, are kept for this purpose, and command a high price. Some of the best flock-masters obtain 35*s*. or 40*s*., and even as high as 50*s*., for their ewes.

One point which struck me as defective in the practice of this district was that there is little or no thought of fatting horned cattle, or consuming the straw, except by treading it down as litter for lean stock and dairy cows. In the neighbourhood of Milborne Port, the practice of muckle-folding is adopted; *i. e.*, the yard-litter is spread on the fields, and the sheep are folded on it, to tread it in.

This deficiency, if such it be, is very important in its bearing on the state of the labourers, which is very deplorable: their wages are depressed to the lowest possible point. The causes of this depression I will examine hereafter; but I cannot leave this district without bringing together three facts which appear to me

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those of a half-bred South Down ram, 15½ lbs.: the bones of younger animals would doubtless weigh less. I have since met with some information on the subject in Mr. Morton's Cyclopædia of Agriculture: the amount of bone taken off 100 acres by growing stock is there estimated rather higher than I have given it in the text.

to afford matter for useful reflection when taken in combination:—1st. The district is singularly favourable to the growth of flax and wheat. 2ndly. The straw of the wheat, and the seed of the flax, are neither of them to any extent consumed in the district as food for cattle. 3rdly. The population is large, perhaps redundant; wages are low, poor-rates are high; and yet it is now generally admitted among good farmers that the judicious combination of the use of straw-chaff with linseed, either as jelly or cake, is one of the most economical ways of making large supplies of meat and manure, while house-feeding and flax cultivation both increase the demand for labour. It is surely premature to talk of giving up the growth of flax. Would it not be better to review the whole process of its preparation, and to inquire whether improvements which have been adopted in Belgium, Norfolk, and elsewhere, may not be imported into this district, and combined with the profitable feeding of cattle in addition to the sheep now folded on the land?

That the extensive introduction of house-feeding into a district which has hitherto relied on the sheepfold will involve a considerable outlay in building, cannot be denied. In this respect several yeomen residing on their own estates have set an example of what is really required to make the most of the land, and I found some tenants quite willing to use accommodation for feeding purposes, if they had it. I need only refer, in confirmation of what I have stated, to the practice of Mr. Cuff of Merriott, who farms his own land. The arrangements made by Lord Portman and his steward, Mr. Parsons, for feeding at West Lambrook, show that they are alive to this subject. At the latter place every convenience is provided that can be desired for feeding stock of all kinds, and for the preservation of manure on a large scale.

In Mr. Nicholls's Prize Essay on Flax, republished under the title of the 'Flax-grower,' will be found a great deal of useful information on this subject, tending to show that the market value of the flax depends very much on the colour which it has acquired in the process of steeping or dew-retting, and how much the amount of profit is affected by the economy and skill with which the various operations have been performed. I am indebted to the same gentleman for the information that a new process has been recently introduced from America for steeping or watering, which is said to be successful:—that is by using tepid water heated to a certain temperature by steam in long troughs, in which the operation can be carried on at any period, winter as well as summer. But it may be travelling too fast to speak of new machinery and steam in a rich corn-growing district where threshing-machines are comparative strangers. If

some leading proprietor would pick out an intelligent workman and send him to visit the districts where the preparation of flax has been most carefully attended to, he would confer a great benefit on his neighbourhood.

A few other points on the south side of the county require notice before we pass out of the Middle district.

The management of the sandy and stonebrash land on the high ground running from Castle Cary to Milborne Port is not very unlike what has been described. The soil is still lighter. The rotation of crops professes to be on the four-course system; but I saw a list of crops for eight successive years on eight different fields near Castle Cary, in which there were several instances of wheat, barley, oats, in succession. This, however, is uncommon. Sheep-folding is universal. Few animals of any kind are prepared for the butchers near Castle Cary; and near Milborne Port there is the same absence of bullock-feeding which has been noticed above, and the same distrust of bones and of all artificial manures.

I met, however, a very good Sherborne farmer who manages one of these farms for the widow of a friend, and he has satisfied himself that farmers ought not to depend so exclusively on the fold, and that roots ought to be grown with artificial manure. He has found it answer to use dissolved bones on similar land on his own farm. He further deviates from the custom of the country by fattening good beasts in his yards, and often wins some of the first prizes at Yeovil.

On the confines of the sands and clays near Cadbury Castle there are several farms well deserving attention, some of very high value. While riding along the road I met one farmer, full of quiet intelligence, who was "putting his shoulder to the wheel" on a farm for which he is paying a rent of 1000*l.* a-year for between 300 and 400 acres: and as he pays it regularly, his landlord has the good sense to leave him to crop his land exactly as he finds it answer best. Among other points of interest in this neighbourhood were Mr. Paul's Devon stock, and are still the new buildings, of most luxurious dimensions, which his landlord is erecting. Mr. Blandford, who is farming his own land at Weston Bampfield, has put up a set of buildings far superior to what are commonly seen in the county.

Chalk and Greensand.—On the south of the sandy land near Crewkerne is a farm on the chalk, Combe estate, managed in a very superior manner by Mr. Salter, a tenant of Lord Poulett's. He stands pre-eminent in this part of the county for the excellence of his implements. He has a water power, with which, in addition to the ordinary farm operations, he crushes bones; a drying kiln for corn; a well selected set of field implements,

including Chandler's liquid-manure drill, with one of Hornsby's drills, and the best scarifiers, pressers, ploughs, and harrows.

Mr. Salter's farm is about 700 acres. He has introduced, on a part of his land, a three-course rotation; two root-crops in succession, and one wheat-crop. He considers it most profitable, under present circumstances, to keep a dairy, a large flock of sheep, and to grow the finest quality of grain alone. Food for stock is therefore a prime consideration. By bringing his cows in early, he is able to let them at a higher price; the same holds good of the sale of his breeding ewes. The stubbles having been broken up immediately after harvest for vetches, turnips and swedes are sown with superphosphate in the summer. They are consumed on the ground, and a crop of mangold follows with little expense.

Mr. Salter keeps a fine dairy of 40 Devon cows, and about 500 breeding ewes, besides other sheep. His testimony to the value of the Dorset flock is very strong. Some years ago he gave up keeping Dorsets, and went to considerable expense to raise a Down flock from stock obtained from Mr. Ellman and other noted Sussex breeders; but, after seven years' trial of them, he has returned to the Dorsets, and he is quite satisfied that they pay best. His flock is a very prime one, and commands high prices at Weyhill.

Passing along the Crewkerne and Chard Hills, and leaving some good farms near the latter place, we may ascend the Black Down Hills, of the farming of which little can be said that is favourable. The land is in the hands of men of no capital, who employ hardly any labour. It is famous for its oats, a crop for which the land below is too good. Two corn crops in succession are still the rule, and not the exception; and the all-consuming course of wheat, barley, oats, and clover cut, is not yet a matter for the historian of by-gone times. There is, however, on these hills one experiment which must be viewed with interest. Mr. W. Beadon, of Taunton, who has always been a sanguine believer in the elastic powers of British agriculture, has given his friends an opportunity of testing his theory by his own practice in an extreme case.

The estate of Wyke, in the parish of Otterford, rests on the greensand, which is covered with flints, rubbly soil, thin clay, and peat. He is farming the greater part of the estate himself. occupying 180 acres of arable land, and 200 of grass, a very small part of which is water-meadow, but he holds 15 acres of meadow in the Vale to help him in the spring. He has added to his estate lately by the purchase of 700 or 800 acres of poor common, which he is about to reclaim. Before he took the estate in hand it employed four men, and there was not one

cottage on it: he has added six cottages, and employs twelve men, besides many women and children. There used to be 5 acres of turnips; there are now 55, and next year there will be 80. I saw a field of swedes and another of turnips on the ground. The crops were good over the whole of the fields. He has at the present time 75 head of horned cattle, and 270 South Down breeding ewes, besides 110 ewe hoggets from last year, and 20 pigs, 15 horses and colts. The wages paid amount to 500*l.* per annum, and one result is that there are no labourers out of employment in the neighbourhood.

As Mr. Beadon is only in his fourth year as a practical farmer, it would be premature to form conclusions as to the results of his experiment. He himself is satisfied with the past, and hopeful for the future.

Eastern District.

The eastern, or rather north-eastern, hilly district is very different in its character from the hill country of the west. It does not consist of distinct lines of hill divided by deep stream valleys, but it gradually slopes away from the top of the limestone ranges to the rivers Avon and Frome. Its combes are often dry, instead of bubbling with watercourses, and the appearance of its pastures, its ponds, its stone walls, and thorn hedges, indicate a difference in the soil and agricultural management.

The geology, instead of being simple, presents a greater variety than perhaps any other district of equal size in England, and yet it is remarkable that various circumstances have tended to perpetuate an uniform system of dairy farming over the lower ground, without much regard to the varieties of soil, a system under which less capital is invested in the land, either by landlord or tenant, and more rent paid in proportion than under any other. The consequent deficiency of employment for agricultural labourers is not felt as much as might be expected, on account of the number of men who work in the collieries.

It will not, therefore, be worth while to trace out minutely the connexion between the varieties of the subsoil and the traditional practices pursued on the small proportion of land which is under the plough. The full account of these practices given by Mr. Billingsley 50 years ago makes it the less necessary to go over the same ground. I am afraid I may incur the charge of prejudice or presumption for the remark, as all my knowledge of the east of the county is derived from recent inquiries; but the details of the ordinary farming of a district appear to possess little interest, when the state of things is one for which, in the natural resources of the soil and climate, there is no justification. Overcropping with grain, fields full of weeds, the neglect of

turnips and of artificial manures, in a district containing two of the best markets in England, and bounded on two sides by the railway, are evils which require no detailed discussion to suggest a remedy. It will be a more pleasing and useful task to point attention to the improvements which are slowly taking place, and to some shining examples of superior farming, which have done more to expose deficiencies than a hundred essays could do.

The farming of Mendip (to begin with the highest land adjoining the Middle district) has of late years shown some signs of improvement. "The soil of these hills," says Mr. Billingsley, "is, for the most part, deep, loamy, and of a good consistence, and, were the climate more genial, could not fail of being productive in all seasons." Mr. Billingsley's advice to the landlords was "to provide all necessary buildings for making mountains of dung," and to the farmer "to grow little corn, and that little in the highest perfection;" to "have a great breadth of turnips, cabbages, potatoes, and other artificials," and, consequently, "to maintain a great stock."

By these means, he said, the lands might be kept in a progressive state of improvement, and if the then "prices of agricultural produce were not greatly reduced, neither landlord nor tenant would have much reason to complain:" his calculations were founded on 6*s.* a bushel for wheat, and 2*s.* 6*d.* for oats.

Unfortunately, the course taken was the reverse of these wise suggestions; the Mendip enclosures were made under the temptation of war prices; allotments on the hill were assigned to homesteads in the vale below, already insufficient for the farms to which they belonged; and the farmers in their turn grew oats without manure as long as the land would bear it. It was but lately that a farmer who had taken three crops of oats in succession from one field, on being asked what he was going to do with it next, replied that he wished to take as many oat crops as the land would bear first, he should then lime it, and take only two crops, as he wished to lay it down for grass in good heart!

Of course this kind of tillage must come to its limit at last, and so the new enclosures were laid down in grass to rest. After they had been in grass some fourteen or fifteen years, another system was hit upon which supplied the great desideratum by enabling the farmer to spend little and go quick to market. The land was let out at 1*l.* an acre to poor men for one year, who breast-ploughed it and took a crop of potatoes; the farmer was thus enabled to get a succession of oat crops in alternate years at little or no expense to himself, and to have a good return the first year, often not less than 7 or 8 quarters per acre. Within a circle of no great extent round the Ninebarrows might be seen 2000 acres or more cultivated on this plan. Then came the

potato-disease and the fall in prices, which have put an end to this system. A spirit of improvement has at last crept into the district, which the owners of the land might turn to great advantage by patient and wise attention to its requirements.

What has been said refers chiefly to the north-east slope of Mendip. The south side of the hill is differently circumstanced, owing to its contiguity to some of the best cheese-land.

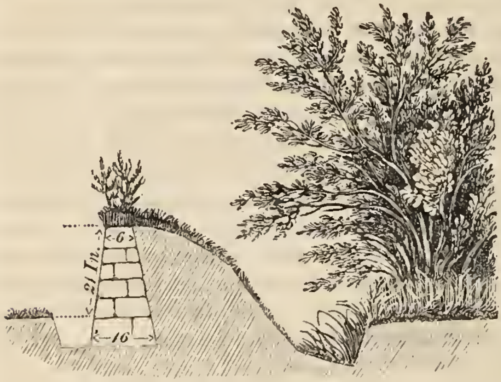
Immediately above the alluvial soil which runs at the foot of the hill-side is a rich strip of new red sandstone or marl: above this is a conglomerate, and higher up a beautiful sheep-walk on the mountain limestone, too thin to repay for tillage. These different sorts of land are held in small portions with the dairy farms of the Marsh, to which they afford great accommodation. Mr. Edwards of Hutton, the resident agent of one of the principal properties near Axbridge, has been gradually introducing great improvements, both in the buildings and in the management of the land; a rational system of cropping was at first enforced, and is now adopted on conviction. One of the farmers said to me, "When a man has grown an acre of mangold-wurzel one year, he is sure to have two the next."

To the eastward of Axbridge are some properties in a very bad condition; but there is one remarkable spot embosomed in a hollow of the hill, sheltered from winds, and open to the south, in the highest state of cultivation. The land is occupied by tenants called croppers, who pay rents amounting to 5*l.* or 6*l.* per acre, which they are enabled to pay by never letting the land lie idle, and growing crops of vegetables in rapid succession, which they carry to the Bristol market in their "dillies," as their light platform carts are called. The land is red marl, probably improved by the washing of the limestone above.

Ascending the Mendip Hills from Wells on the Frome road, I met with a good specimen of an industrious Mendip farmer, who was storing as fine a crop of swedes in November as any landlord could wish to see. He acknowledged his obligations to the gentleman whom I am about to name, and to whom all the owners and occupiers of the Mendip land must feel indebted for the spirited example which he has set.

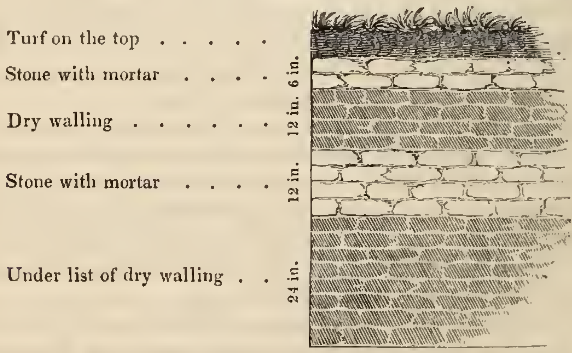
Mr. Henry Davis occupies about 1400 acres of land, a large portion of which is at Green Ore, on the summit of Mendip, and some adjoining the road along which we used to travel on the Bath and Exeter mail. Much of this land was in heaps and holes, varying from 6 to 15 or 20 feet deep, old calamine pits, which he has been gradually levelling and fitting for the occupation of future tenants. The first step was taken with great judgment, by surrounding the estate with picturesque plantations (which, by the way, are not thinned quite so well as the turnips), so

that many of the large open fields, being perfectly clean, have the appearance of the home paddocks near a gentleman's house, and the shelter of the plantations is invaluable to the crops and the stock. The fields are provided with ponds, so placed as to supply four fields at once, and bounded by good thorn hedges, or by fences against the plantations, which are made on a simple



and cheap plan with dry walls and banks; the wall is built first, about 20 inches in height, and sloped from 16 in. to 6 in. in width, so that it may stand firm if the bank gives way, the greater slope being on the inner side. The wall with turf on the top is put up for 8*d.* per rope, or inside bank and wall together for about 16*d.* per rope of 20 feet long, and quicks are planted on the top.

Some of the fields are divided by dry walls, built 4 feet high, at 1*d.* a foot (20*d.* per rope length) the whole height; in other places the fence is what is called a list wall, alternate layers of



dry wall and stone with mortar; the expense of a list wall of 4½ feet high, besides the turf at the top, is about 3*s.* 4*d.* per 20 feet (viz., building wall, 2*s.* 8*d.*; lime, 9*d.*; turfing, 3*d.*), besides making the foundation and hauling the stone.

A recent mode of cultivation has been to spread dung on the sward after two or three years of grass, and plough it in, roll it with a heavy roller, then apply about 5 quarters of lime per

acre, drill in the wheat, tread it with sheep, harrow it, and tread with sheep again. Some of the Mendip land is a peculiarly light black mould, which looks like vegetable peat, but leaves a considerable ash when burnt, and requires a great deal of pressure.

Mr. Davis adopts a five-field course, leaving the grass out two years; he sows his turnips with 2 cwt. of superphosphate and ½ cwt. of guano; this is sometimes applied with a liquid-manure drill, at the rate of 3 hogsheads of water per acre, and sometimes with ashes, the latter with rather the best effect.

Mr. Davis thinks it an important point to put in the turnip-seed soon after ploughing, when the land is dry, and not on a stale furrow, as advised by Mr. Graburn on the lias stonebrash. The climate is unfavourable for clover, but Mr. Davis grows very fair fields of rye-grass, of which he sows as much as 2 bushels per acre.

He also finds great benefit conferred upon old grass by spreading lime on it at the rate of 160 bushels to the acre, soon after it is mown, one heap to every perch, which is slaked at once with a little water, and brushed in while it is hot. This practice is mentioned by Mr. Billingsley as producing durable effects which might be seen for 15 or 20 years. It also agrees remarkably with Mr. Blake's practice on a very different soil in the west. The turnips and grass were looking very fine in the fall of the year, and about 1500 sheep on one portion of the farm in very good condition. If his oats are not well harvested, he passes them through the chaff-cutter (as Mr. Smith intends to do on Exmoor), and gives them as chaff with cake to the sheep.

Mr. Davis, like all men whose standard is a high one, is very much alive to the points in which his practice falls short of his ideal; and though he most kindly afforded me every information, was unwilling that his farm should be held up as a model. Some apology is perhaps due to him for this crude account of his estate; but at a time when the attention of landlords must be turned to the practical means of maintaining the cultivation of their estates, it is a duty to draw attention to the means by which he has brought wild Mendip land into good cultivation, and, assuredly, a large part of the hill must be reclaimed over again before it can be properly farmed.

It is a matter of no little interest that some of Mr. Davis's buildings were erected by Mr. Billingsley, and that the horse-wheel of the first threshing-machine put up in the county is still in use. Some of the neighbours say that Mr. Davis has been at great expense; that if the estate were let it would soon go back, for that Mendip land is proverbial for its "short memory." In the first place, I have ascertained that common report much overrates the expenses; in the next place, if the land have a *short*

memory, it is the more important for its owner to have a little foresight, and to take care that it should have all the needful appliances for keeping it "*in heart.*"

A few miles from Mr. Davis's estate is a farm of 308 acres, the property of the Roman Catholic Society of Downside College, in their own occupation. When we call to mind the services rendered to agriculture by the monks of the middle ages, even in Somersetshire, it may excite less surprise that this is one of the best appointed and best managed farms in the county. It is situated on the slope of Mendip, at Stratton-on-the-Fosse, exposed to cold winds, subject to severe frosts and fogs. The soil a sour loam on a hungry gravel, with large blocks of conglomerate stone which are very troublesome.

The buildings are well arranged, with a steam-engine and good accommodation for stock, all but the pigs, whose habitations seemed in much want of ventilation. I observed an useful arrangement for preservation of manure; two catch-pits side by side under a shed for the reception of ashes, to be saturated with liquid manure. They are used alternately, one being full of ashes and receiving the liquid, while the ashes from the College are being accumulated in the other.

From 90 to 100 head of short-horned cattle are constantly kept, including 25 milch cows, 25 or 30 calves reared, and 10 beasts fattened annually, besides 250 sheep and pigs.

Mr. Pippet, the manager of the farm, has given me an account of its produce, from which it appears that the quantity of animal food produced on this farm annually (allowing 15 gallons of milk to be equal to a score of meat) is considerably more than 2000 score. This is a produce of 7 score per acre over the whole farm, or, deducting 45 acres for the portion of tillage land in wheat, oats, and barley, above 8 score produced by the grass, green crops, and inferior grain, without any artificial food. Moreover, the cost of the labour employed on the farm amounts to 390*l.*, or about 25*s.* per acre over the whole farm, two-thirds of which is in grass. A large portion of this labour has been employed in permanent improvements on the pasture lands.

In crossing the country between the Mendips and Bristol, the traveller cannot fail to be struck with the goodness of some of the land, and the backward state of the farming. The absence of turnip crops and the deficient quantity of stock are most remarkable, and even in the fields of the best farmers the hoary look of the stubbles and clovers tells tales of overcropping.

Where the coal strata are on the surface the soil is generally poor. But the Mendips, Broadfield Down, Dundry Hill, and the coal strata mark out a triangle of land, with Wrington for its apex, and a line through Compton Dando, Clutton, and

Stone Easton for its base, requiring perhaps as much improvement and as likely to repay for judicious outlay as any in England; few possess greater natural resources or are more favourably situated for obtaining manures and implements, or for the disposal of their produce. I gathered that two of the principal landlords in this neighbourhood have of late years been employing labour in draining on liberal terms, and agreeing to the removal of needless hedgerows.

In the centre of this district, about Chew, is some land belonging to trustees of charities in Bristol, in a neglected state; and a number of small properties purchased as investments by residents in the same city, who are content, if their rent is paid regularly, to leave matters much as they found them.

More than two-thirds of the land in this district is pasture; in some parishes the arable land does not amount to one-fifteenth of the whole. The produce is principally butter and inferior cheese. The cows are almost universally kept out of doors at all seasons, foddered with hay, roots being little cultivated. It is not an uncommon practice to fatten the bull calves on a stage with milk, when veal sells well, and the butter market is dull.

Between the limestone hills and the sea lie the marshes which have been before referred to, stretching from Uphill at the mouth of the Axe, to King's Road at the mouth of the Avon. The moors of Yatton, Kingston, Seymour, and Kenmoor are occupied by yeomen graziers, who supply the Bristol market with beef and mutton in the summer and autumn. Tickenham and Nailsea Moors are in a bad state, but likely to be soon improved.

Between Clevedon Hill and the King's Road lie the Clapton and Walton Moors, of a peaty description, which are broken up about once in five years, and laid down again; they are let in lots of from 20 to 50 acres to farmers, who find them very valuable in dry summers. Below them is some fine grazing land, about Portbury.

At this point we are close to Leigh Down, near Bristol, which in Mr. Billingsley's day was a sheep-walk, but is now in part occupied by Leigh Court, the beautiful residence of one of the most practical farmers in this part of the county, Mr. William Miles, who occupies 430 acres of arable land and 400 acres of grass land, including the park, in which there are 180 head of deer. The greater part of the land is an extremely thin layer of clay on the limestone, with a few fields on the new red sandstone.

The Leigh farm is in a very high state of cultivation, and managed in a very business-like way. The accounts are kept with great accuracy in a plain and simple form. The buildings are well arranged and useful, without being needlessly expensive. The course of crops is suited to the soil:—1. Mangold; 2. Wheat;

3. Winter-Vetches followed by Mustard; 4. Wheat or Barley; 5. Turnips; 6. Barley; 7. Clover; 8. Wheat or Oats. The land is subsoiled at least once in the course, generally after the 4th crop, early in October, so as to be as little trodden as possible. The roots are always sown upon ridges at 27 inches apart, in order to horse-hoe twice before singling, which is done by hand. Great care is taken to deposit the seed at an even depth; the quantity of dung has been reduced from 24 to 12 loads, with 3 cwt. of guano.

The cultivation of roots having been very successful, a large quantity of stock is kept. About 30 short-horned beasts are annually reared, and the same number sold at about 8 cwt. each; about 300 Southdown sheep are sold at 15 lbs. a quarter. The situation appears in some degree unsuitable for high-bred Southdowns; 25 cows are kept in milk, and many pigs. It will be found that this produce amounts to about 3000 score of meat, besides the deer, allowing the milk of a cow to be equal to 20 score of meat—a result which is confirmed by the sale-book, showing the number of pounds actually sold in the year ending Lady-day, 1849, to exceed the quantity above estimated. This is another instance of the importance of roots and stock, occurring as it does on land which Mr. Billingsley said would not admit of cultivation, and was only fit for the pasture of sheep.

Following the banks of the river from Bristol towards Bath we pass some deep stony land near Keynsham, and come to the high land between Bath and Wells, from which the ground falls on the east side to the Frome water. I was informed that near Hinton, St. Philip's Norton, Wolverton, and Beckington there is some good grazing land, and that Mr. Feever, of Stoney Littleton, has some very fine stock of the Hereford breed, which are as good milkers as high-proof animals can be expected to be. Mr. Craddock, of Lyppiat, has a herd of Herefords not to be surpassed in their native county.

About Timsbury and Radstock there is rich sound land, to which sheep used to be sent in great numbers for the winter from Wiltshire, and still are sent from the Mendips.

There is little to boast of in the arable cultivation of that part of this district which lies nearer to Bath: as far as I have been able to learn, the deficiency of root crops and of winter food generally characterizes the farming: a low average of stock and a deficiency of good manure are the necessary consequence. The sheep are of various kinds, chiefly cross-bred between the Cotswold and Leicester, and not a few nondescript Irish brought in by way of Bristol, some of which, however, are not very bad in quality. Many farmers content themselves with breeding a few cross-bred sheep, selling the lambs in July, and the ewes, in middling con-

dition, at the fall of the year for others to finish, instead of wintering them on turnips, and growing vetches to bring forward another set in the early spring, an improvement which was introduced into this district about fourteen or fifteen years ago by Mr. Knatchbull, of Babington House, and which some of his neighbours have since followed. It is to be regretted that he has given up farming; but there are two farms well deserving the attention of the agricultural visitor—that of Mr. Woolley, a tenant of Mr. Gore Langton's, at Wilmington, near Bath, and that of Mr. Jarrett, of Camerton Park, on the road to Wells.

Mr. Woolley's farm is on one of the beautiful knolls of oolite resting on lias; the soil is a sort of stonebrash, and favourable for sainfoin. He therefore sets apart a portion of his farm, about 15 acres. for that plant, the remainder of the farm he divides thus: one-eighth clover; one-eighth rape, or early turnips sown in May and consumed in August; one-quarter swedes and mangold; and the rest in grain; and he has not broken this course for 15 years. The sainfoin becomes "ruggy," as it is called, in about 4 years, and then it is changed to another piece of land.

Mr. Woolley is very careful in his method of folding, with a view to the subsequent crops. The lambs get the first run of the clover pen, and leave their manure for the wheat during the night. In the morning they are moved to the rape. The draft ewes follow the lambs on the rape, and lie there at night, then finish what the lambs have left in the clover field, and go to grass to fill their bellies, returning to the rape or turnip-stumps at night. It is thus arranged that fatting sheep should always sleep where wheat is to follow, and also have the benefit of frequent change. Mr. Woolley also feeds a large number of Devon oxen in stalls. He had very fine swedes, which were carefully "placed" in heaps. His good example has not been without its effect; there is a gradual though slow improvement in the district. He remembers that 25 years ago there were not 20 acres of turnips for some miles round his farm; now you may see 100 acres in any direction.

Mr. Jarrett has rendered great service to the neighbourhood since he began farming; he took a farm in hand and bought the tenant's team; he was told he would kill the horses by ploughing with them two abreast: he has continued to do so for eleven years, and one of the horses is alive and at work still. He has put up some very substantial and useful buildings. There is a very good piggery, from which the liquid runs under cover to a tank, which is to be filled with the ashes of weeds, which will be saturated and make manure for the drill. His turnips are excellent, and the stock which consumes them not less so. The

good effects of Mr. Jarrett's farming might be seen in the appearance of the farmyards of his tenants.

Near Frome there is some good farming. There are several brothers, Messrs. Steeds, who have a very large business in that town as butchers, who are men of capital, energy, and intelligence; they buy very largely whatever is worth having in any part of Somersetshire, and occupy several farms, which they manage with spirit, producing the finest stock. Whether they are geologists I know not, but they seem to have a keen eye for the patches of new red sandstone which are scattered among less profitable soils; I understand they have taken contracts to deliver meat at the Paddington station very much below the London prices.

There is a large property managed by Mr. Raines (who was brought up in the school of the founder of the Royal Agricultural Society, Mr. Handley), on which improvements are quietly taking place; and I must express my special obligations to this gentleman for the assistance he gave me at the commencement of the inquiries needful for this Report.

The bed of clay which stretches southwards from Frome, at the foot of the Wiltshire hills, is of a very unmanageable character. Sir Hugh Hoare has made a very spirited outlay on some most discouraging land adjoining his Wiltshire estate. The Rev. Mr. Marindin, of Shank's House, has done much to improve the dairy farming near Wincanton; and the Rev. Mr. Plucknet, who farms his glebe at Horton, has set an example of thoroughly practical farming on bad land at a great elevation. The soil is on the forest marble, and very wet, but he has shown that some of the land will grow wheat in alternate years, with vetches and mangold-wurzel between, and has introduced some useful implements suited to the wants of the small farmer; he has also induced his neighbours to use bones for their turnips.

Sorts of Grain and Roots.—Enough attention is not paid in some parts of the county to the selection of seeds. In the hills particularly there has been great carelessness on this subject, and oats are produced at 7 lb. a peck which might, with a little care about seed, have weighed 10 lb. Several of the sorts of corn, grass, and turnip seeds used by the best farmers have been mentioned. Mr. Clarke (engaged largely in the corn-trade at Street) recommends in addition the nursery wheat, as having the power of ripening after it is laid, but not good for poor soils; also the Chiddam and April bearded. Mr. Hancock showed me a rick of hoary Talavera, which he believed would contain 300 bushels from 6 acres. Mr. W. Miles has found the Hopetoun very successful on his poor soil in the east. A wheat called Rattling Jack

is a favourite in the western district. Mr. Alexander Luttrell has taken some pains to introduce Spalding's in the western hill country, and (from the account which I had from a very intelligent miller) though it fetches a lower price, it appears to be the best wheat to sow where red wheat alone can be grown: I saw several ricks estimated at 50 bushels per acre.

Till a few years ago, the only turnips grown were varieties of the white, the greenring being sown for late feeding; but now the Scotch, Aberdeen, golden yellow, Dale's hybrid, and Skirving's swedes are generally valued.

Scalded or Clouted Cream and Butter.—It is the practice in the dairies of the west of the county to adopt the Devonshire practice of warming the milk about 12 hours after it has been taken from the cow. The process need not be described here, as a full account of it is given in Mr. Tanner's Report on Devonshire.

It is a common opinion that the object of the scalding is to extract from the milk a larger quantity of cream and butter. I was once led to doubt the correctness of this opinion, and having made many inquiries, and received the most contradictory answers, I requested an intelligent farmer's wife to make the experiment, and the following is the result:—

Twelve quarts of milk were measured and weighed, so as to be sure that the quantities were exactly equal. The result shows a difference in the weight of butter amounting to 7½ lb. on every 100 lb.:—

	Raw.		Scalded.	
	lbs.	oz.	lbs.	oz.
Weight of the milk before setting	29	6	29	6
Weight of milk and cream before cream was taken off, showing loss by evaporation	29	2	28	1
Weight of cream when taken off	3	11	2	8
Weight of butter	1	6	1	4½

The two specimens of butter were analyzed by Professor Way, with a view of ascertaining whether the scalding process produced a purer butter by separating the cheesy matter more completely from the butter. The result was as follows: in 100 parts of each specimen there were—

	Raw.	Scalded.
Pure butter	79·72	79·12
Casein with some sugar of milk and salts	3·38	3·37
Water (by loss)	16·90	17·51
	100·00	100·00
Water by direct determination (drying at 212°).	17·54	17·68

As far as this experiment goes, it tends to show that there is no increase in the weight of butter, but the reverse, produced by the scalding process.

The analysis shows that the proportion of pure butter in butter made from scalded cream is not greater than that which is to be found in ordinary butter; a portion of butter is therefore left either in the butter-milk or in the skim-milk, or wasted in the warming.

The practical advantages of scalding cream are, that the butter is quickly made by stirring with the hand or with a stick without the labour of long churning; and that it keeps much longer.

The first advantage may be explained by the supposition that the bubbles of casein which contain the oily matter are burst by the heat, so that the process of churning is already more than half effected; but the analysis throws no light on the question why scalded butter keeps best. The best dairy farmers near Exeter both scald the milk and churn the cream; they find that by this plan they secure the advantages of scalded cream butter, and without any loss of quantity worth taking into account.

Cider.—A large quantity of cider is made in Somersetshire, of two very different qualities. The ordinary rough cider drunk by the labourer is worth from one to two or three guineas per hogshead, according to the season; the best sweet cider made in the parishes of Kingston and Heathfield, near Taunton, is sold for from three to ten guineas per hogshead, and may be kept for 20 years without losing its quality. The difference in the value is partly attributable to the sorts of the apples, and to the nature of the soil; but the principal difference consists in the mode adopted in the making; and especially in the means adopted for stopping the fermentation at the right point. In the ordinary practice the stoppage of the fermentation is a matter of chance; the object aimed at by good cider-makers is to reduce that chance to a certainty by using great care.

The juice of apples contains a variable percentage of sugar and also of vegetable gluten. The gluten subsides to the bottom of the cask, and as soon as a certain quantity has been deposited, it causes the liquor to ferment.

The object of the cidermaker is to allow as much fermentation as is necessary to produce a vinous fluid, and to get rid of the gluten as soon as possible after this has taken place. But as this gives a great deal of trouble, the ordinary course is to allow the fermentation to proceed till nearly the whole of the sugar has been converted into carbonic acid and alcohol, with perhaps a portion of vinegar, and the result is a harsh intoxicating liquor with no nourishment in it. In the best cider a large portion of the sugar is preserved and there is comparatively little alcohol.

The usual routine of cider-making in Somersetshire is the same as that practised in Devonshire, which has been fully described by Mr. Tanner in his Report on that County.

The practice of Devonshire and Somersetshire varies from that of Herefordshire chiefly in the fact that whereas the west country makers merely crush the apples, the Herefordshire makers extract the flavour of the pips and skins by a very slow process of grinding the pulp. Some improvement might probably be made in our cider-mills by which the latter object might also be obtained at less cost of time and labour.

Some few makers near Taunton now use a simple Saccharometer for testing the quantity of sugar in the cider. It is a graduated glass tube, loaded at one end so as to float upright in a liquid. It sinks to zero in distilled water at a medium temperature, and rises in very rich new cider to 60°. The maker is enabled by this instrument to ascertain the original quantity of sugar in the apple-juice, and the extent to which the fermentation has proceeded in the cider by the consequent loss of sugar.

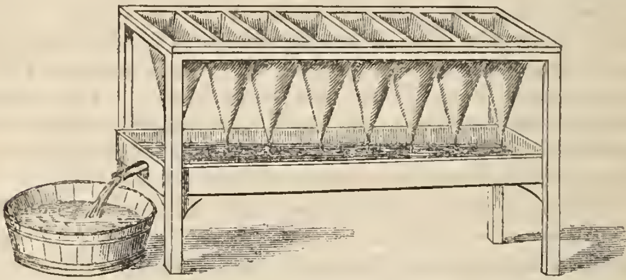
Mr. Crosse, of Broomfield-lodge, states that in the year 1848 the best new cider did not contain more than 45° of sugar, whereas in a fine summer it contains 60°, showing a difference of 25 per cent. dependent on the full elaboration of the juices of the fruit.* He has also been kind enough to allow me to insert the following practical suggestions in this Report:—

"A certain mode of ensuring good cider is the following:—First press out the juice, not earlier than the month of November, then test it by the saccharometer—say that this instrument stands at 55°—allow it to remain in an open vat, till the instrument points 50°, then match it and cask it and stop it with a syphon bung, or inverted syphon, one end protruding from the bung of the cask, and the other let fall into a cup of water, placed on the side of the cask. The moment the least sign of incipient fermentation takes place rack it again, and, if necessary, match it again, returning the cider into the cask. Repeat this at intervals when necessary, closely watching it. Generally six or seven rackings and two matchings will suffice. After these the cider is fit for my process of purification, which is effected as follows:—Make a frame so arranged as to hold a long trough in the position of an inclined plane, with legs below to support it nearly horizontally, and a support above it to contain eight bags of moderately thick calico, each formed like a jelly-bag, and large enough to contain three pails† full of cider. These bags are arranged side by side, and in such a manner that the fluid thrown into them runs out at their pointed ends into the inclined trough below, and is thus conveyed into a tub placed to receive it. For convenience each bag is attached by strings to a square frame, which rests upon the framework of the apparatus, and can be removed at pleasure for the purpose of being washed, &c. The night before the purification of the cider the liquor is racked into an open vat, into which a solution of isinglass is poured and well stirred up. This con-

* There is a very full treatise on Cider-making, written by Mr. Andrew Crosse in the 'Library of Practical Agriculture,' published by Mr. Baxter, of Lewes.

† Sixteen pails to the hogshead.

sists of one ounce and a half of isinglass boiled in three pints of old cider till dissolved, and then strained through a hair sieve. On the following morning the liquor is again stirred up and ladled into the bags, into each of which a small teacupful of powdered charcoal has been previously thrown. The liquor when thrown into the bags is as foul as thin mud, but in a few minutes runs out as clear as the finest Bucellas wine. It is then tested for the last time by the saccharometer, and it ought never to be under 40° to make first-rate cider. It is then immediately casked and bunged down tight, and if well made will never ferment again. It should be bottled the following March—being then three or four months old, as the case may be. This mode of purification saves infinite trouble, as without it it is not uncommon to rack it upwards of 20 times, and match it 5 or 6 times, and the cider is not half so good and much waste takes place."



Planting.—There are not many extensive plantations in Somersetshire. Those of Lord Poulett, between Chard and Crewkerne, are thriving and extensive, well and regularly thinned. There are large plantations on Lord Portman's property at Staple Fitzpaine, and on various properties on the Quantocks, Brendon, Porlock, and Winsford Hills.

The following are the maxims of a very experienced planter, who has superintended woods in the last-named hills:—

Selection of Plants.—Choose short stiff plants from a nursery where they have been transplanted two or three times.

Sorts of Plants.—Larch trees are good nurses to other plants, and come to be useful early; but in exposed situations Scotch must be planted amongst them; and in very exposed situations there should be a belt of Scotch or Pinaster against the west.

Time of Planting.—In dry soils plant before Christmas; in wet soils after Christmas.

Placing the Plants.—Plant thickly at first—3 to 5 feet apart—and as irregularly as possible; they stand better for thinning, and break the wind better than when they are planted in straight lines.

Thinning.—In a thriving plantation thinning must begin in five or six years. The best way is to cut the browse and lower branches first; then, for two or three years, take out any that are touching their neighbours, or are getting weak; after that, *i.e.*

after the ninth or tenth year, thin once in two or three years. The trees that are left ought to be strong enough to stand the wind and keep upright.

Pruning.—When the branches of larch or Scotch begin to die, it is better to cut them off in October or early in November; but they ought never to be cut above half the height of the tree.

Other trees ought not to be pruned, except to take off false leaders and to check the tendency to forking.

The greatest difficulty about plantations is how to deal with them after they have been neglected forty or fifty years, and have been allowed to grow thick and weak. Great care must then be taken to thin but very little each year for several years, taking out only the weakest plants, till those which are left get strong enough to bear their own weight; after that once in two or three years will do.

Felling.—When timber woods are cut down, make a clear sweep—don't leave any small trees—they never grow to make anything, but are generally stunted.*

Implements.—Not much can be added to the science of agricultural mechanics from the traditions of this county.

On the west of the Parret the common tool is the long-handled Devonshire shovel, with a pointed end; to the east, a long, narrow spade, with a cross-piece at the top: the first is suited for stony ground; the second, for the soft alluvial soil. A low single-horse cart like a large wheelbarrow, called a three-wheel put, is common in the hills for wheeling out dung, or carrying the soil to the top of the fields from the bottom, whither it is annually washed down. On the same ground the corn is often harvested in crooks on horses' backs. The old-fashioned two-way plough is a clumsy implement for ploughing backwards and forwards on the sides of hills, always throwing the furrow-slice down hill. The only two ploughs of the kind that are good are Lowcock's patent plough, made by Ransom, and a turn-wrest plough, made by Comins, of South Molton.

Mr. Billingsley said that in his time there was not a single threshing-machine in the county: they are now very common in the western district, not unfrequently driven by water. Mr. Blandford, of Orchard Portman, has a re-action water-wheel, which is propelled so rapidly by the pressure of a high column of water on its flanges as to require no gear-work; but he says it has not power enough for any but very light work. He has a portable steam-engine, which he lets out. Mr. Miles has one on his farm; and there are three in the lias district, not far from Somerton; I believe there are some near Frome, but principally

* This last maxim is too generally stated. It may be true of high ground: on low ground it is doubtful. There is experience in Somerset both ways.—PORTMAN.

used in Wilts. Mr. Morle, a most spirited tenant-farmer at Cannington, has lately ordered one of Clayton and Shuttleworth's 3-horse power engines.

It is surprising how few improved agricultural implements have been introduced into the southern part of the county; but near Taunton the case is otherwise. There are some good implement-makers on the east of the county bordering on Wiltshire. In the best farmed districts of the west the smiths are slowly improving, but they want knowledge and encouragement. Carson, of Warminster, makes a scarifier which is very much in use; and two machines of Moody's, for mashing or cutting turnips, which are much approved. One is an inverted cone of bars, through which the turnips are squeezed in a pulpy state by a circular revolving grating, set in motion by a pony; the utility of this machine is, I think, very questionable; but the other is an invaluable implement for economising the consumption of roots. It is similar in its action to Gardner's turnip-cutter; but the turnips are cut into much thinner strips; so that when given with chaff, they stick to it, and are so thoroughly mixed with it, that the animals cannot pick out the turnips alone. It has twelve knives on the barrel, so that it cuts nearly as fast as Gardner's, though cutting so much finer.

Manures.—It has already been stated that in one part of the county the fold, and in others farm-yard dung, are considered all sufficient. This estimate of the value of dung might be very wise, if more were done by the generality of farmers to produce a great quantity of it, to make it rich in quality, and to keep it well. Some of the most careful lay a mattress on the ground under the dung-heap, composed of ditch scrapings, weeds, and refuse of all kinds, draw the carts over the heap to press it well down, and spread over it what may (by a parallel metaphor) be called a coverlid of earth, out of old hedges and cobb walls. Mr. Corner draws the litter out of his straw barton (the yard where young stock live on straw) into the hay barton (where beasts are living better), so that all his straw is saturated with rich matter. Box-feeding is, I think, unknown, unless there may be some who do as Mr. Gould, of Broadclist, did many years ago, before Mr. Warnes brought boxes so much into notice—viz., sink their stalls about a foot below the level of the yard, and let the litter be well trodden for about three weeks. Instances of soiling cattle and horses in the house during summer have come under my notice in two farms near Bishop's Lydeard and Staplegrove. The last-named case is virtually box-feeding, and very successful in its results.

A west-country farmer seldom thinks much of confining the liquid which runs from his dung-heap, being quite satisfied that

if it flows into his pond it will sooner or later find its way over his water meadows. It is true that ammonia is freely taken up by water; but there may be much waste in the yard from the action of the sun and air before it reaches the pond; and it is not at all clear that all the valuable salts held in solution by the pond-water are left by it on the ground as it trickles over the meadow. Tanks are very uncommon, and, except as a means of preserving dung, their utility is very questionable. I know but one practical farmer in the west of England (and he is a bit of a theorist) who thinks that it pays to carry out diluted urine, except on a small farm, or that it is safe to carry it undiluted, although several have tried it. A better arrangement will be mentioned under the head of Buildings.

One of the manures of most interest in Somersetshire is the deposits of its rivers. The form in which this can be used with most advantage, is the flooding of the lands with thick water. It may, however, be used as Mr. Graburn has used it at Butleigh, as a vehicle for a compost, especially when the manure is dibbled.

The following are the analyses of three specimens:—No. 1 is from the Parret at Bridgewater, taken from a silt bank of recent deposit, on Messrs. Seeley's brick-yard (Bath-brick is made of it); No. 2 is the clay taken from the banks of the Brue, in Westhay Moor, and laid by Mr. Galton on his peat land. The sample was taken from one of his clay-boats; it had a number of minute shells in it. No. 3 is taken from the banks of the Brue, at Butleigh, about ten miles higher up, and is the earth used by Mr. Graburn.

	Parret at Bridgewater.	Brue at Westhay.	Brue at Butleigh.
Water	1·21	3·72	2·64
Organic Matter	2·02	5·52	4·06
Sulphate of Lime	6·61	·44	0·86
Carbonate of Lime	13·98	14·43	17·18
Phosphate of Lime	0·39	..	0·20
Magnesia	trace	trace	trace
Potash	0·33	0·36	0·51
Soda	0·28	0·30	0·31
Sand and Clay	67·11	62·37	64·22
Oxide of Iron, Alumina, and Loss	8·07	12·86	10·02
	100·00	100·00	100·00

Underground Draining.—The progress of draining may be in some degree estimated by the number and situation of the tileries which have been called into existence of late years. I have met

with fourteen tileries in the Middle and Eastern Divisions. The Western Division draws its supply by sea from Bridgewater. Nevertheless, underground draining, as a system, has yet to begin in the Marsh, and yet no land is more easily drained where there is a fall, or pays better for it—for wet land is the stronghold of couch, a thick mat of which may be generally seen on each side of a surface-gutter.

Mr. Gabriel Poole has set a useful example of draining on a farm which he has purchased near Bridgewater; he drew my attention to a remarkable peculiarity of the alluvial soils: the surface is frequently more tenacious than the subsoil; a horse footmark will hold water like a dish, till it evaporates, close to a drain which is in full work. The land frequently becoming more sandy the deeper you go, he recommends that in draining alluvial soils the distance of the drains should never be fixed till a trial has been made; the water discharged by the first drain he cut was found at a foot below the surface, and a 3-inch pipe laid at a depth of 4 feet could not discharge it. He cut a second drain at 60 feet off, and did not find water till he had dug 3 feet 6 inches down; he was therefore satisfied that the first drain was acting for 60 feet on each side, and drained the whole field 4 feet deep at that distance, and the drainage is quite effectual; he has had magnificent crops of mangold-wurzel and corn. In King's Sedgemoor I met with some marl-draining, that is, drains filled in with a marl very common in Somerset, and almost as hard as stone when first dug up. Mr. Gillett, of Higham, informs me that his father has practised this plan for many years, and that drains put in with marl 25 years ago act as well as the day they were made: the material suits deep draining, as it must be laid deep to be out of the way of the air; the marl must be broken very small, as small as stones for the highways, and stones or some hard material must be placed at the mouth of the drains: the reason why marl is used in Sedgemoor is because stone is very distant, and the ground is so spongy that there is much doubt about pipes answering without collars.

On the confines of the lias and oolite, in the heavy clay about Alford, drainage has made rapid progress of late years; and some useful examinations of old drains have been made, all tending to increased confidence in deep draining with pipes. I am informed that the tenants are satisfied that their produce in corn is raised to the amount of a quarter per acre, and are beginning to grow mangold-wurzel.

Of the draining in the Western Hill country not much need be said, except that system without common sense and observation will not carry a drainer through a single field, so rapid are the changes of the subsoil in the red sandstone and grauwacke,

and *one drain well laid to suit the circumstances will often save a dozen by rule.*

I saw a contrivance on Mr. Corner's farm on Brendon Hill which is worthy of notice. One of his water-meadows is on two sides of a falling combe, with a stream down the middle, a very common case; instead of cutting a new main carrier, he has straightened the stream and sloped its banks gradually away, bringing each separate drain into its bed; he finds that in this way, as the field is always dry, he gains good grass to the edge of the stream, and if any pipe is choked he can find out where the fault is immediately.

Farm Buildings.

Enough has been said already to show that the strong point of Somersetshire farming is not the excellence of its buildings. The dairy farmers are in the worst position, for they have often no buildings at all for cattle. An agent for a large property told me that when he first came into the county he was surprised at the wasteful and injurious custom of foddering on the grass lands, and introduced a clause into his agreements forbidding it after a certain day in the autumn. The tenants said, "before you forbid this you must put up proper buildings, for we have not room for half our beasts;" and he was obliged to strike out the clause. A farmer in the Bridgewater district, after explaining how roots may be grown on the lias clays, says, "but before this can be done, buildings must be put up to economize manure, for it is only by extraordinary manuring that this land can be fitted for the growth of turnips;" and he adds, "that on the whole district (west of the Parrett) the buildings are utterly unsuited to the improved methods of farming."

Such, it is to be feared, is the true state of the case, speaking generally, throughout the county. Of course there are exceptions. On some properties to which the owners have given their personal attention, there has been a gradual and general improvement; on others a few buildings have been erected from the ground, the rest biding their time. The instances of farmsteads, completely arranged with a view to the adoption of the recent improvements in machinery and cattle feeding, are very rare. This is partly owing to the small scale of the farms and to the large proportion of grass land. Among the buildings lately erected which have attracted attention, is one on Lord Portman's property at West Lambrook; it is a very large establishment, constructed and occupied by his steward Mr. Parsons, whose great mechanical skill is exhibited in the arrangements for preparing corn and food for cattle. The threshing machine, with its elevator and straw-rake, is perhaps one of the most complete in

England, and a large sawing-mill and planing-machine are annexed; but the establishment must be viewed rather as the central factory of a large property than as a model farm building for ordinary purposes. There is a building planned by Mr. Kidner, who occupies a farm belonging to Mr. Cridland, not far from Wellington, which comes near to the idea of a compact West Country homestead, suited to a vale farm where the fatting of sheep and beasts is the object rather than breeding or the dairy; but it is somewhat deficient in modern mechanical arrangements. In the same neighbourhood Messrs. Fox, the clothiers, of Wellington, who have taken to farming, have very good premises; and a building in course of erection by Mr. Sanford, at Chipley, deserves notice for combining improved threshing-floors and feeding arrangements at a moderate expense. The farm-buildings of the Roman Catholic College of Downside have been already referred to.

Now that the attention of landowners and farmers is forcibly directed to the problem "how is the land to be managed with the least waste of any of its resources?" it is plain that every farmer, who has the means and the will to exert himself, will expect to have a fulcrum on which to rest his lever. The solution of this problem, as far as it relates to farm buildings, requires an attentive consideration of the habits of the county and of the peculiarities of our soil and climate, combined with a readiness to learn what we can from the improvements made elsewhere.

It is with unfeigned distrust of my own judgment that I venture to offer any suggestions on a subject of so much importance. It was the saying of a wise man (before the Reform Bill), "when you doubt, leave things as they are." Now there is much doubt as to the best mode of arranging farm buildings, and yet it will not do to leave things as they are. But in the spirit of the maxim referred to, I venture to suggest that it is inexpedient at the present moment to hastily stereotype in brick and mortar either old and costly arrangements or new theories imperfectly worked out. Many expensive buildings were put up fifty years ago which are unsuitable to the farming of the present day, and hinder reasonable improvements only because the walls are so sound. Under these circumstances perhaps the wisest course a landowner can take at the present time, when he has many farms to deal with at once, is to make some temporary arrangement with the tenant for putting up the required accommodation according to the custom of the country in the simplest and cheapest manner, that is, in such a manner as a tenant might put up a shed for himself under a lease of moderate duration. Several instances of what I mean may be seen on Mr. Sanford's property near Wellington. Landowners generally are not aware how cheaply

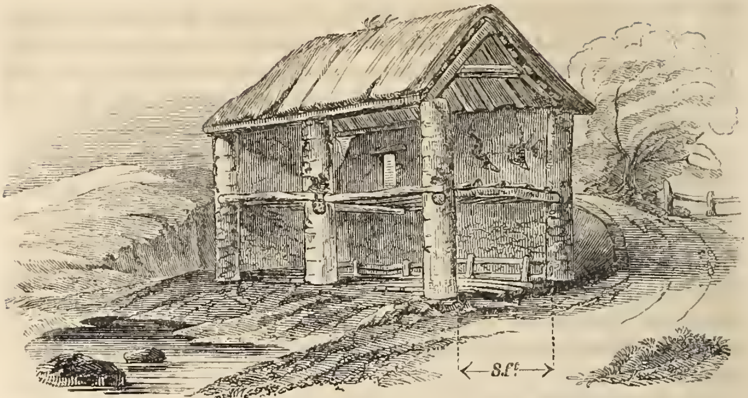
this can be done, nor will they be aware till they look into the matter thoroughly for themselves, and make it the interest of the tenants to assist them in keeping a check on the expenditure, by taking them into personal consultation and considering how the greatest convenience is to be obtained for a given sum.

The humidity of the climate must be taken into account in all West Country buildings. One of the peculiarities resulting from this cause is the building of a second storey or loft over all bullock-sheds: it is called a "tallat." Tenants in the west are rarely satisfied without them. As to the expediency of this custom the most opposite opinions are held and acted upon by practical men of no less authority than Mr. Hancock of Halse and Mr. Blandford of Weston Bampfield, when building on their own estates.

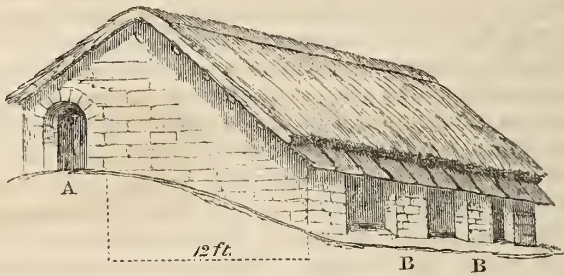
It is true that one roof is made to serve for two floors, but when the extra walling, long pillars or posts, joists, and flooring are reckoned up, the tallat will be found to add 50 per cent. to the cost of a shed. The common "tallat" linhay (1) standing by itself in an exposed situation is a very bad arrangement; it gives little shelter, and the hay in the loft is sure to be wasted. A far better plan for the hills is a low building such as Mr. Corner's (2), with wide piers and low projecting roof. If "tallats" be advisable, they ought not to be mere lumber-rooms or hay-lofts. They may be made subsidiary to more economical feeding arrangements instead of means of waste, and so may tend to economise space and masonry. They should then be arranged as at Mr. Kidner's (3), well floored, with a parapet, and connected with the threshing-floor. In this way the "tallat" may be used as a straw-barn upstairs, or as a floor for chaff-cutting, turnip-cutting, grain-bruising, and other purposes.

The whole system of barn economy requires to be reviewed, and the improved threshing-floors and rooms for dressing corn adopted with due regard to our climate, which is not so favourable for out-door threshing, or for taking in ricks when wanted, as the east of England.

In the meantime the pressing point is to provide sufficient means for bringing all the horned cattle (and ought we not at the present day to say some of the sheep too?) under or within reach of shelter. Now, shall we put the cattle into byres or under sheds—leave them loose in boxes or tie them up—or, lastly, let them have the small yard and shed combined as in Lincolnshire? or, shall we wait the issue of Earl Fortescue's public spirited experiment now in course of trial at Castle Hill—and gather cattle, sheep, and pigs on various stories under one great roof? Meanwhile there are hundreds of farmers in Somersetshire who would be glad to have some common linhays of poles and thatch



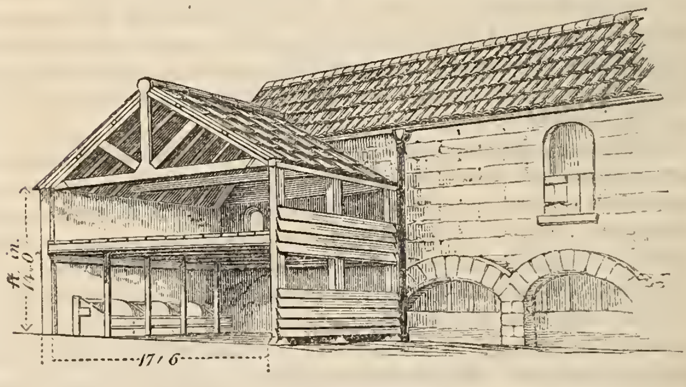
(1.) Old-fashioned Tallat Linhay.—Width 8 ft. in the clear.



(2.) Linhay at Mr. Corner's, King's Brompton.—Width 12 or 14 ft. in the clear, besides Turnip House.

A. Turnip House behind. B. Piers about 6 feet wide.

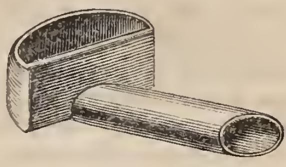
The roof comes so low that the bullocks have only just room to pass under.



(3.) Improved Tallat on Mr. Kidner's farm near Milverton.—Width 17 ft. 6 in. in the clear. The upper storey is well floored with a parapet of boards, and communicates by a door with the barn.

which may be put up, with a turnip-house included, for 1*l.* sterling per bullock (as I saw at Mr. Roals' on Brendon Hill), and would last very well for ten or twenty years while more permanent buildings are gradually in progress—the possibility of a regular payment of rent, the while, being almost contingent on what is done at the present time and done speedily.

It may be well to specify one or two practical details which may be generally useful. One of them is a contrivance which I met with on Mr. Hannam's farm on the top of Exmoor; it well deserves the attention of dairy farmers. He has an ordinary steaming-apparatus for preparing food for pigs, scalding milk and whey, &c., so arranged that all the waste steam is turned through a common stove-funnel, which passes up into the cheese-room at the top of the house, and traverses the whole length of it, at a moderate height from the floor. It has the best effect in ripening the cheese at no expense except the original cost of the pipe, which is trifling. Mr. Hannam tried zinc first, but it did not answer so well.



Mr. Yeoman has all his milk poured from the pails through a hole in the wall of the dairy, by means of a tin vessel shaped so that it can be removed and washed. The men discharge the milk at the nearest point to the sheds, and no time is lost by gossiping in the dairy. The whey is conveyed underground to the reservoir near the pigs.

Two arrangements for saving pig-manure seem worthy of notice. One is that devised by Mr. Raines of Mells. A large hovel or outhouse is enclosed at the sides, so as to be at once warm and airy; the floor is paved and sprinkled over three-fourths of its length with burnt clay and ashes of weeds; on this part of the floor the pigs are fed, and they have a clean bed of straw railed off at the other end. A great quantity of excellent manure ready for the drill is thus made, and the pigs are always clean, warm, and comfortable. The other may be seen at Messrs. Fox's, the clothiers, at Wellington, who have lately taken to farming. They have a covered pit, into which all the litter of the beasts and horses is thrown, and all the liquid from the stalls and stables conducted underground. The principle of box-feeding is then ingeniously applied by a large number of pigs being kept in the pit: they enjoy themselves greatly, and thrive well, treading down and improving the dung. I have since heard from Sir Thos. Tancred that this plan has been adopted by a practical farmer in Hertfordshire, who says that his pigs have given him a profit by their meat, and left the dung as good as guano for nothing.

There remain a few points of general reference prescribed by the Council for consideration, which have been touched on incidentally in various parts of the Report, and one which must be treated of more fully.

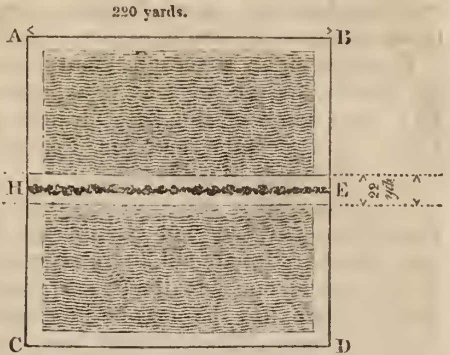
Small Inclosures and Hedgerow Timber.—In no part of the county is the evil greater than in the vale of Taunton Dean. Its beauty (so familiar in the days when, on a stage-coach, we did sometimes pass over the top of a hill instead of going through it) depends, alas! in great measure on the richness and frequency of its hedge-rows, giving as they do the appearance of a vast wood to the whole valley when seen from an eminence. In many places the hedges are so close that the roots of the elm-trees must meet under ground. The evils of these small inclosures are many: 1st. The hedges being planted on high banks take up a great deal of land. 2ndly, They cause a great waste of time in frequent turnings of the ploughs, drills, harrows, &c. 3rdly, Being large and bushy, they harbour weeds and vermin. 4thly, They intercept the sun and air, and by so doing hinder the growth of crops, delay their ripening, and check the drying current of air which is so important in harvest. The closeness, also, is productive of great mischief to sheep when feeding in hot weather in close valleys. 5thly, Another very serious evil connected with hedgerow timber, which affects the owner as well as the occupier, is the great risk of drains being stopped by the roots of elm trees. The same roots also draw away the nourishment, and especially the moisture from the root-crops. Mr. Gabriel Poole has drawn my attention to a remarkable fact which he has observed:—

"Barley and turnip crops in a dry summer grow nothing within 20 yards of a hedge, if it contains any considerable quantity of timber. In these situations turnips are almost invariably mildewed, and if you scrape away the surface-soil with your foot as far as you see the mildewed turnips extend, you will find that the small roots of the trees have sucked out every drop of moisture from the soil, and left it like the dust of a turnpike road. You can see to an inch how far these roots extend, and one foot only beyond that line you will find that at the depth of only an inch or two below the surface the ground is moist."

Landlords sometimes think that the effect of hedges is only to lower the value of part of a field by the amount of 10*s.* or 15*s.* per acre, whereas the real effect is to destroy its whole value in rent, and in addition the value of the manure and labour, amounting to probably twice the rent.

A square furlong, as A, B, C, D, measures 220 yards each way, and contains 10 acres; if it be divided into two 5-acre fields by a hedge, H, E, 6 feet wide, and full of elm trees, it is below the mark to say that the loss extends 10 yards on each side, that is, (including the hedge,) 22 yards;

the taking down of this hedge would add an acre of available land to the farm. The amount of land injured inside these two small fields, to say nothing of the other side of the hedge, is two acres and four-fifths, allowing that a breadth of 10 yards only is injured, which falls short of the fact.



It is difficult to say to what extent hedges ought to be removed, but if, by way of beginning, it were agreed as a general rule that fields should be not less than 10 acres, and that ash and elm trees should be cut down when they injure arable land, a great step would be gained.

Causes and Remedies of Foulness of Land.—The cause is mainly overcropping with white crops, neglect of growing green crops, and of keeping them clean when grown; and, as will be noticed in the Marsh, want of draining. The remedies are so obvious, that, except in reference to weeds affecting certain soils, which are noticed in their places, it may suffice to say—"Where there's a will there's a way." The drill and the horse-hoe soon pay their expenses.

On farms which are already tolerably clean it would be well to adopt the plan of going over the stubbles in the autumn with small forks, to fork out the couch while it is in patches and the roots near the surface; it may then be gathered into heaps to be carted away. I saw a field of Mr. Hudson's at Castleacre, in Norfolk, so cleaned at a cost not exceeding 1*s.* an acre, and had great pleasure on returning home to find that two friends and neighbours had long practised something of the same sort. I mentioned the practice to a very good farmer near Sherborne, and was told the thing was impossible without a ploughing first.

Cultivation of Green Crops.—Not much can be added to what has been stated in the accounts of the best farms. Green crops in the vales suffer more from warmth and drought than from any other cause. It may be taken as an established fact that in the low ground early sowing of turnips and swedes is sure in ordinary seasons to lead to mildew. It follows as a consequence that the drills should not be so wide as in the north of England, where the root has a longer time to swell.

It is now an admitted principle among gardeners, that to roughen the surface in drought is the sure way to prevent evapo-

ration and to promote growth. It is the opinion also of most good farmers that the frequent use of the horse-hoe checks the mildew; but even good farmers near Taunton still set their drills so close that the horse-hoe cannot be used.

It seems to be a settled point that sowing on the ridge does not answer in the vales, as it exposes too much surface to the air; while some of the best farmers on the hills, such as Mr. Snow, of Cutcombe, and Mr. Peard, of Highercombe, are decidedly in favour of ridges.

I have met with two details of practice which may be useful elsewhere. Mr. Lang, of Hambridge Mills, near Ilminster, sows two rows of red mangold alterately with two rows of yellow globe. The leaves of one sort tend to spread and of the other to rise; and by alternating the sorts he promotes free access of air to both.

Mr. Salter, of Combe Farm, near Crewkerne, who grows mangold after swedes and before wheat, sows rape between the rows of mangold the last time of hoeing. The swedes having been fed off with sheep the year before, the mangold crop is grown with little expense; the leaves of the mangold and the rape are partly eaten and partly trodden in, and form an excellent preparation for wheat. He hauls out large heaps of ashes saturated with urine in the autumn, and places them in the fields where vetches are to grow after the stubble and before the swedes; he has only to add the bones in the spring. The chief part of the dung goes on the grass.

The state of the Labourers as to Employment, with the means of increasing it, and as to their Habitations.

This is the last subject prescribed for discussion in this Report; it involves every point which bears on the improvement of the general standard of farming in the county; and there never was a time when it required more serious consideration.

There are three principal rates of money-wages paid to day-labourers in different districts. Before the recent fall in prices these rates were 9*s*., 8*s*., and 7*s*. or 6*s*. The highest rate is in the neighbourhood of the coal-pits, the lowest in the south of the county between Yeovil and Ilminster, and in some of the poor hilly parishes. Carters, of course, receive a rather higher rate or have some advantages.

About Taunton and Bridgewater, and generally on the best managed farms out of the coal district, the intermediate rate is paid. In a few parishes in the Marsh, where the labourers are very independent, the highest rate is given. Since the fall in prices wages have fallen in some parishes, but by no means in all. In addition to money-wages are given what are called privileges; a substitute for real wages which may mean an

advantage or a loss to the workman according to the disposition of his master. These are generally three or four pints of cider per day all the year round; wheat at 6*s.* per bushel in all seasons; potato-ground, let at a "shilling a lug," that is 8*l.* an acre, sometimes as high as 10*l.* an acre, the farmer ploughing and manuring the land; and sometimes a cottage at a low rent or rent free. Of the cider I will speak presently. The wheat at 6*s.* is an advantage to labourers who bake at home, provided it is sound and good wheat, worth about that money; but as the system commonly works, the labourer is practically obliged to take inferior wheat at more than it is worth, and truth compels me to say that I have met with too many proofs of unsaleable wheat of 1848 being forced upon the labourers this year at the rate of 5*s.* or 6*s.* a bushel, or tailings wheat at 6*s.*, when the best quality is not worth more than 5*s.* 9*d.*: such practices meet with no countenance among the more high-minded farmers. Some, however, of the kindest masters, who have made no change in their wages, continue to give the same proportion in wheat as heretofore, by which the labourer, if he does not gain, at any rate does not lose by the fall of prices. But, unfortunately, the example of these masters gives an apparent sanction to a great abuse.

The system of potato-ground has been in great measure superseded by allotments, or by the failure of the root.

The value of a cottage when allowed to a labourer as a part of his wages depends on its state of repair, situation, garden, and on whether it is partly or wholly an addition to or deduction from the current rate of wages. It places the man in his master's power; on the other hand, it probably secures him regular work, and relieves him from house-rent if he is ill for a few weeks.

I now come to the cider question, which I will not attempt to argue, though I have heard one gentleman of education defend the practice of paying part of the wages in cider. The fact is that the masters and men play into each other's hands, the women and children suffer, and the men, too, in the long run. The labourer in a year takes off his master's hands about two hogsheads of cider, and satisfies one of his own bodily appetites at the cost of 15 per cent. of his earnings. The liquor refreshes and stimulates him, but wears him out, for common cider is not nourishing, but exciting like spirit and water. West country labourers will never be what they might be as long as this system goes on.

The following fact, so simply told by Mr. Danger, and so much to his credit, will do more than many arguments:—

"For some years I have paid my labourers in money, instead of the

usual way, partly in money and partly in cider. When I first began, which was 11 or 12 years ago, I just proposed it to my people, who said in reply that they could not work without cider. Determined, however, to try my plan with them, instead of *requiring* them to work without cider, I said they should have their wages in money, and if they chose to have cider they should pay me for it. In this way it was left to *themselves* to have it or not. Their wages were raised 1*s*. 6*d*. per week. That is, a man whose wages were 9*s*. 6*d*. per week, if he drank 3 pints of cider per day, took home with him on the Friday 8*s*. Another man, who perhaps was satisfied with two pints, had 8*s*. 6*d*.; and the man who had none during the week would have 9*s*. 6*d*. When left to their own choice, it is not the case that the labourer will always take cider instead of money; but I believe that when required to work without cider, they generally think it a hardship. Whatever others may say on the subject, I have found, when left to their own choice, particularly during the winter months, the labourer prefers money to cider."

Mr. Paramore has acted upon a plan not wholly unlike Mr. Danger's; and Mr. Poole found it answer to give his labourers in harvest-time money to buy a hogshead of cider, and to leave them to drink it as they pleased; they drank less, worked better, and earned more than on the usual plan; and paying, as he does, a high rate of money-wages, he is satisfied that his corn was harvested cheaper than that of his neighbours.

There is a strong and just feeling among many tenants that landlords ought to do more to provide the labourers with decent cottages near their work, instead of driving them into towns and villages, where they must pay as much as 4*l*. for a miserable house without a garden. A very distinguished tenant farmer has sent me a calculation, showing that the time lost by the labourer walking four miles daily is equal to several years of his life. He says, "The master is at some loss, but the great loss is to the man; imagine this time spent in his garden, what comforts would it have given him." "And yet," he says, "at this time landlords are taking down cottages on their estates." It is at least encouraging that the desire to keep the labourer and his family at arm's length, which I noticed to my surprise in Lincolnshire, is not shared by tenants in Somersetshire.

The practice of clearing off cottages in close parishes, at which my correspondent hints, may, I fear, be found within this county in several instances; it is difficult to come at the exact truth and justice of such cases without knowing all the circumstances. But if proprietors were aware of the deep feelings excited by any attempt to evade the fair burden of providing houses for those who labour on their land and relief for those who are disabled, the satisfaction which they may derive from the skilful management of their estates would be much diminished.

Speaking generally, the number of bad cottages with one room upstairs is diminishing, and several landlords have improved the

dwellings of the poor; how much more is needed those know best who are familiar with the moral degradation which ensues on crowding all the members of a family into one small sleeping-room. There are many small tenements in Somersetshire, built by the poorer classes on small freeholds, copyholds, and life leases, in many cases on Church property; these are frequently mortgaged, the occupier clinging to his little property with as much tenacity as the head of the oldest gentleman's family; the interest of the mortgage is considerably less than the rent of a cottage would be; but the houses are often in a very bad state, and the inhabitants much distressed.

In the practical adoption of the system of "*field gardens*" for labourers, Somersetshire is in advance perhaps of all other counties. The late Bishop of Bath and Wells (Dr. Law) was one of the first to promote it. In East Somerset twenty years ago, I am informed, that except by him not a rood of land was so appropriated. In 1831 Captain Scobell, to whom I am indebted for information on this and other subjects, was led by the circumstances of England at that time to turn his attention to the subject; he met with support from a few, and was thwarted by the many; but in that year the system was planted in the parishes of Midsomer Norton and High Littleton, and he has now 130 field-garden tenants in those parishes and North Brewham. The land is let at the wholesale price which a farmer would give for it, not a farthing more or less. He informs me that it requires about 8 acres in 1000 acres to make the system universal, and he estimates that there are now in the 250 parishes of East Somerset 1000 acres so appropriated, occupied by 5200 families, helping to maintain therefore 26,000 poor men, women, and children. He believes that each acre so applied has created 80 full days' work annually, and yields a produce of nearly 20*l.* over and above rent, which is on the average 2*l.* per acre. As to the social value of the system, Captain Scobell adds, "Take the fact which I answer for, of the entire occupiers of field-gardens in the two parishes of Midsomer Norton and High Littleton during nearly 20 years, only three have been convicted of crime."

The Rev. H. Stratton Coles, Secretary of the Chard, Crewkerne, and Ilminster Association, informs me that about 1000 allotments are let by the Society in 38 parishes; he adds that the value set on their allotments by the poor is very great; he says, "A quarter of an acre, at a fair rent, if properly cultivated, will produce vegetables worth 1*s.* 6*d.* or 2*s.* per week, in addition to the rent, manure, and labour, and this without the cost of a farthing to the landowner, whose rent is paid, and land improved." The Rev. W. Chilcott, of Monksilver, in the western part of the county, has for many years made great exertions to promote the

welfare of the labourer, as secretary to an association founded exclusively for the encouragement of the labourer. Agricultural Societies, for giving prizes to labourers, show at least some sympathy for the working man, and help to remind others of his needs. But what is a "coat, buttons, and framed testimonial of merit" in return for a life of labour?

After all that palliatives can do, the question remains, why are wages so low, and how are they to be raised? I know of only one answer—wages will rise when there is more work to be done or fewer hands in proportion to the work.

In order to cure the evil, we must look it fully in the face, and know what is the present disproportion between the number of the labourers and the land under cultivation. Let us compare the population of some of the best arable land in Somerset with that of other districts less fertile by nature, in which farming is carried to a far higher pitch. For instance, in the hundred of South Petherton we find 46 persons on 100 acres; in the large parish of South Petherton itself 80 persons on 100 acres, and in three neighbouring villages there are as many persons as acres.

Contrast with this the position of the labourers in West Norfolk and on the heath and wolds of Lincolnshire. In the hundred of Freebridge Lynn, in West Norfolk (containing the well-known farm of Castle Acre), there are only 17 persons to every 100 acres, or about 6 acres to a person, and the wages till lately were 11*s.* a week. In Largo Wappentake, on Lincoln Heath, there are 14 persons to every 100 acres, and in the hundred of Brocklesbury-on-the-Wolds, 11 persons to every 100 acres, or 8 acres to a person, and the wages 12*s.* a week. The consequence is that the farmers have no more workmen than they absolutely want all through the year, and strangers are in request in harvest-time and all times of pressure.

And though it may be said that these are extreme cases in each county, still if we take the average over the whole of the three counties, there are for every 100 acres in Somersetshire 41 persons; in Norfolk, 32; and in Lincoln, 22; and inasmuch as very much more than half the land in Somersetshire is grass land or uninclosed, the disproportion between the population and the amount of agricultural employment is greatly increased.

The fact is, that in the district between South Petherton and Yeovil, unless the glove trade is thriving, the people suffer the most severe privations, and although the earnings of the women and children as glove-sewers in the villages of this district help to eke out the maintenance of the families, the reliance on this uncertain trade causes the farm-labourers to accept in ordinary times a rate of wages almost below the minimum of human subsistence. The earnings of the glove trade, even at the best, are cruelly cut

down by an infamous system of truck practised by small shop-keepers, who act as middlemen, and refuse work to all the women who will not submit to it.

This is not the place to inquire how far emigration would be the best means of diminishing the pressure on the labour market. The question proposed is—what means are there of increasing employment within the county?—In answer to this question it may be replied, that there are thousands of acres in Somersetshire which require underground draining—that there are large tracts of fen or peat moors, on which clay or marl might be spread with advantage—that good stone roads are required throughout the marshes—and that in order to make such investments of capital profitable to the fullest extent, great improvement in the whole system of sewers and drains is required. Many acres more of turnips and mangold-wurzel might be cultivated, and except on a few of the best farms the green crops and stubbles plainly show how much the farmer loses by not spending more on labour to keep down weeds.

The permission to break up inferior *grass lands* is perhaps one of the simplest modes by which the owner of land in Somersetshire may benefit at once the labourers and tenants. The temptation to abuse the permission by excessive grain-cropping is not great at the present time, and when the dairy farmer has learnt the value of mangold-wurzel, he will be as fond of his roots as of corn.

As my anonymous friend on the heavy clay farm says, "One fact is worth a volume of theory:"—On a small dairy farm of 41 acres, on the green-sand, in the east of the county, consisting entirely of grass, there was a piece of 4 acres, worth about 20*s.* an acre, and yielding not more than 15 cwt. of hay per acre. The tenant was allowed and encouraged to break up the field six years ago. He ploughed it in the spring, sowed it with vetches, by which smothering crop the sward was quickly decomposed. He has ever since tilled it in portions of wheat, swedes, mangold, and vetches, and has always had good crops: from 8 to 11 sacks of wheat; from 16 to 30 tons of swedes; and from 30 to 35 cwt. of straw per acre. *This account of the crops comes from the tenant*, who describes the accommodation and advantage as very great.

There is a great deal of grass-land on the borders of the lias hills, which scours cattle. It is said to be "teart;" that is, tart or sour. Some persons attribute this to a plant called Linum Catharticum, others to the water; but whatever be the cause, the effect is very ruinous to the farmer, and of course the value of the land is lowered. The grass which scours most is the quick growing grass, after the hay has been cut. No remedy has yet been found for the evil, and it varies much with the season; but it is observed that cattle put on the grass in good condition are least

liable to be affected. The breaking up of a portion of this land would assist the farmer to bring his cattle into condition before he turned them out; and if it were found to answer, the plan might be carried further.

In all that is said of breaking up grass-lands, it must be remembered that the grass which is yearly mown and pastured by milch cows, unless it is constantly manured, is, despite of covenants and twenty-pound penalties, in a steady course of deterioration, which nothing but a judicious expenditure in green crops on the fields in question, or on adjoining fields, can change into improvement.

It may be safely assumed that out of the 500,000 acres estimated as grass-land in Somerset, there is a twentieth part, which having been thus impoverished for a long course of years, does not yield a gross produce of 2*l.* 10*s.* per acre, and on which not more than a tenth of that sum, or 5*s.* per acre, is spent in wages. Supposing that 5 acres on every dairy farm of 100 acres were broken up, it would be a low estimate to say that the produce would be doubled; that is, that on an average of years, twenty bushels of wheat at 5*s.*, or twenty tons of roots at 5*s.* per acre,* might be expected. Supposing that of the additional produce 20*s.* per acre were spent in wages, there would ensue an increased demand for more than a thousand able-bodied men in constant work, at 9*s.* 6*d.* per week, being at the rate of more than three out of every hundred labourers over the whole county; and in the event of these lands being drained, which they probably would require to be, there would be additional employment for three or four times that number of men during the winter months for several years.

Other suggestions might be made; but I proceed to state in conclusion some facts which I believe will furnish at once a measure of the standard of farming in the county, and of the demand for labour.

Statistics of Green Crops and Meat produced.—The facts I am about to state have been placed in my hands in the most kind and liberal manner,—with a view of testing our state of forwardness in the race of agricultural improvement by a comparison of the quantity of meat annually produced on some farms in Somerset with that produced on some well-managed farms in other parts of England.

If the quantity of meat turned off a farm annually is large, it may be presumed that the grass and green crops are good, that the farm is free from weeds; therefore that much labour is employed if it is in great part arable; and that a large quantity of

* Roots are frequently sold now at 15*s.* per ton, or 1*s.* per cwt., not only near the large towns, but in other parts of the Marsh.

good manure is made (whether from the produce of the farm or from artificial manure is immaterial). Where these qualities exist in a high degree, it may be inferred that in a favourable season and climate a high proportion of grain will be grown according to the nature of the land: at the same time it tells nothing whatever as to the profits of the farm, because all this may be effected at a heavy loss to the farmer, while the public reaps the benefit.

The columns in the following Table, then, show (1) the situation and soil of several farms; distinguishing (2) arable from pasture land; and giving the total acreage (3); and then (4) the number of animals sold off in one year, with the weight in scores due to each class: if they are bred on the farm, their whole weight is stated, and the young stock which are being reared to take their places are not entered: if they have been bought in, their weight when purchased is deducted: milch cows, letting in ordinary times at 10*l.*, are considered equivalent to twenty score. The total number of scores sold off the farm in one year is shown in the next column (5). In the next column (6) will be found the number of scores per acre over the whole farm, that is, the result shown by dividing the number of scores sold by the number of acres on the farm; and in the following column (7) the proportion the meat bears to the number of acres presumed to be yielding green food, that is, to the total number of acres of grass, together with half of the arable land, which on the four-field system would be in roots or grass. On any other system it may be presumed that the produce of one half of the arable land is consumed on the farm. If two-thirds of the arable land be in grass, as in the hills, the inferiority of the soil may fairly be set against this advantage in the present comparison.

The first two cases are inserted to show what unassisted nature will do on rich grass land. No case of artificial produce comes near to this, except the remarkable instance of Mr. Bernard's farm, at Clatworthy (see No. 18). Nos. 3 and 4 show the result of dairy farming: the next two cases, 5 and 6, were communicated in conversation by two farmers occupying very rich land in the south of the county, and farming much better than the majority of their neighbours. In both these cases a considerable portion of the stock goes off in a lean state; and in No. 5 the account is swelled by a large proportion of dairy produce. This must be considered in estimating the value of the animals as manure-makers. The two next cases, 7 and 8, and also No. 10, are estates occupied by tenant-farmers, among the best in the county of Somerset. I am indebted to them for the statements—in their own handwriting—on which my figures are founded. In these three cases there is a large proportion of fat stock. No. 9 is a

1. NATURE OF THE LAND AND DESCRIPTION OF FARM.	2.	3. Total No. of Acres.	4. WEIGHT SOLD IN ONE YEAR, AND DESCRIPTION OF STOCK.	5. Total Weight in Scores.	6. No. of Scores per Acre of whole Farm.	7. No. of Scores per Acre of Grass and Green Crop.	8. Money paid in Wages. Total.	9. Money paid in Wages. Per Acre.	
							£. s.		
1. *Grazing land*, 1st quality (Horsey Slime) . . .	. .	1	1 Bullock (summer) gain 12 score, 2 Hoggetts (winter)	14	14	14	. .	under 5*s.*	
2. *Grazing land*, 2nd quality	. .	38	30 Bullocks (summer) gain 12 score, 30 Ewes, 30 Lambs (winter)	410	11	11	. .	Ditto.	
3. *Dairy land*, near Pennard, 1st quality (Estimate) .	. .	100	35 Cows (4 cwt. of best cheese) . . 770 80 Sheep (in winter) 80	850	8½	8½	. .	under 10*s.*	
3*a*. *Dairy land*, 2nd quality	. .	100	25 Cows (3½ second rate) . . . . 500 50 Sheep (winter) 50	550	5½	5½	. .	Ditto.	
4. *Mixed Dairy and Arable, with Sheep-walk*; the Marsh near Mendip . .	Arable . . . 20 Pasture . . . 120	140	30 Cows (Cheddar Cheese) . . . 600 100 Sheep bred (not wintered on farm) 150	750	5⅓	5¾	. .	not stated.	
			Arable Farms—Central District.						
5. Rich land near S. Petherton and Crewkerne; *Oolite Sands*	Arable . . . . Pasture	280	240 Sheep (old Ewes & Hoggetts, lean) 860 6 Milch-Cows . . . . 120 2 Barrenners 70	1050	3½	. .	. .	not stated.	Ewes sold in lamb for early lambing.
6. Ditto; *ditto*	Arable . . . 200 Pasture . . . 100	300	320 Sheep (old Ewes and Lambs, lean) 620 35 Milch-Cows . . . . 700 4 Barrenners 140	1460	5	7	. .	not stated.	
7. Vale of Tone; *Red Marl*	Arable . . . 200 Pasture and Meadow . . 220	420	20 Steers bred, 15 bought (fatted) . 820 160 Sheep (bred and fatted) . . . 688 32 Milch Cows 660	2218	5¼	7½	. .	25*s.*	Hedgerows well cleared.
8. Ditto; *Red Sands* . . .	Arable . . . 220 Pasture and Meadow . . 100	320	10 Oxen (bred and fatted). . . . 450 140 Sheep (ditto) . . . . 700 Pigs 120	1270	4	6	. .	39*s.*	Permanent improvements, hedgerows, marlings.
9. Somerton Table land; *Lias, Stonebrash, and Clay*	Arable . . . 366 Pasture and Meadow . . 271	640	22 Oxen (bought and kept 2 years) . 612 745 Sheep („ „ 18 months) 1100 10 Milch Cows 200	2012	3	4½	. .	. .	The grass land is very inferior.
			Arable and Breeding Farms—Western District.						
10. Vale of Williton; *Lias and Red Sand* (superior management)	Arable . . . 270 Pasture and Meadow . . 131	401	Bullocks . . . . 800 Sheep . . . . 746 Pigs.—Not stated.	1546	4	6	545 0	27*s.* 3*d.*	19 men, 6 women, and 6 boys employed. Pease largely consumed with turnips.

11. Vale of Nettlecombe; *borders of Grauwacke and New Red Sandstone.* Average good Management	. .	470	12 Bullocks bred and fed . . . . 420 170 Sheep (Notts) ditto 680	1100	$2\frac{1}{3}$	. .	. .	about 10s.	
12. Vale of Porlock and Dunkerry Hill-side; *Stone-rush and Rag, Red Marl and Sand, and open Common*	Arable . . . 160 Pasture and Meadow . . 217	380	15 Bullocks bred and fed . . . . 457 160 Sheep (Exmoors) . . . . . 357 9 Milch-Cows . . . . 180 Pigs. 37	1031	$2\frac{4}{5}$	4	Wages heavy—several old Workmen.		The hill-farm good grass, the common worth little; meadows in the vale good.

Hill Country Farms—Western District.

13. (P.) Average good Management.	. .	300	. . .	892	3	. .	. .	about 15s.	Soil generally inferior, and winters wet and long.
14. (H.) Average good Management.	. .	325	. . .	796	$2\frac{1}{2}$	$4\frac{1}{2}$	168 10	10s.	
15. (N.) Bad Management.	. .	258	. . .	540	2	. .	. .	under 10s.	
16. (S.) Bad Management.	. .	177	. . .	162	2	. .	. .	under 8s.	
17. Winsford; *poor soil.* Rev. B. Michell	Arable . . . 52 Pasture and Meadow . . 18	70	2 fat Bullocks bred and fed . . . 4 Milch-Cows . . . . 35 fat Sheep bred and fed	249	$3\frac{1}{2}$	$5\frac{1}{2}$	. .	. .	Some of the land very inferior.
18. Clatworthy; (all cultivated with green crops) *good Rag soil.* Rev. W. Bernard	. .	22	2 fat Bullocks bred and fed . . . 88 4 Milch-Cows . . . . 80 60 fat Sheep and Lambs . . . . 68 36 Pigs in store condition . . . . 30 Horses not used on farm, say . . 50	316	14	14	. .	. .	Weight of purchased stock and value of purchased food are deducted.

Selected Farms in other Counties.

19. Norfolk (Castle Acre); *Chalk*	Arable . . 1280 Pasture and Meadow . . 180	1460	15 Devons bred . . . . 525 160 Scots and Short-horns bought 2000 300 Down Sheep bred . . . . 1200 1700 half-bred, bought 3400	7125	$4\frac{3}{4}$	$8\frac{1}{2}$	2950 0 including Smiths, &c.	40s.	Oil-cake 7s. per head for sheep—4*l.* to 5*l.* per head for beasts.
20. Lincolnshire (Scawby); *Blowing Sand* in part. Mr. Grantham, jun. . .	Arable . . . 186 Pasture . . . 18	204	10 Beasts (fat) . . . . 500 120 Sheep (fat) . . . . 480 15 Pigs (fat) 105	1085	5	$9\frac{1}{2}$	325 0	32s.	Oil-cake 70*l.*, bones, guano, and ashes 88*l.*; each above 7s. per acre.
21. Lincolnshire (Sutton Wash); *rich Alluvial Clay*	Arable . . . 172 Pasture . . . 63	233	12 Beasts bred and fatted . . . . 600 110 Sheep (90 bred, 30 bought) . . 510 Pigs 50	1160	5	8	380 0	33s.	Linseed cake and manure about 65*l.*
22. Devonshire; Broad Clyst; *New Red Sandstone and Marl, and some poor Clay.*	Arable . . . 200 Meadow . . . 75	275	60 bullocks (bought, fatted) . . 500 200 Sheep bred and fatted. . . 800 Pigs . . . . 400 1700 Deduct for extra keep taken occasionally 200 1500	1500	$5\frac{1}{4}$	9	500 0	36s.	Oil-cake 100*l.*, extra keep 100*l.* Well managed water meadows.

farm in the occupation of the owner. The land is unfavourable for green crops, and the pasture very poor, but the farm is well managed.

The numbers which follow—from 11 to 19—refer to various farms in the west of the county, including that of the Rev. Mr. Michell, which may be taken as a sample of superior hill-farming on poor land, and that of the Rev. W. Bernard, who has endeavoured practically to exhibit what may be done with cheap buildings, simple implements, and a single horse, by the cultivation of green crops, and especially by artificial grasses and liquid manure. He grows no corn, because it does not suit him to build a barn; but he has manure enough to supply more than twenty acres of corn land.

The principal cases of importance in the Eastern Division have already been given in the body of the Report.

At the end of the Table are a few instances of highly cultivated farms, to be found in other counties; all occupied by tenant-farmers.

It appears that the largest proportion of animal food produced on any Somersetshire farm in the list (omitting the marsh grazing land, and Mr. Bernard's experimental farm) is at the rate of seven score to an acre of grass and green crops; and that in the only two cases in the Table in which so high an amount is reached a considerable portion is due to dairy produce.

On the other hand, it appears that in certain selected cases in Lincolnshire and Norfolk, and in one case (there are not many such) in Devonshire, the amount of animal food—all fit for the butcher—produced for every acre of grass and green crops is not less than eight or even nine score.

I think it must be admitted that unless this contrast is capable of some explanation which I do not perceive, it points to some deficiency in the farming of Somersetshire; for it can hardly be accounted for by any want of natural fertility in the soil; nor can it be altogether traced to the excess of hedgerows; for the four first-named arable farms are remarkably free from incumbrances of that kind.

It will be noticed that the consumption of oil-cake forms a prominent feature in the management of the farms selected from the other counties, while in none of the Somersetshire farms quoted in the Table is it used to any extent worth mentioning.

I am confident that the amount of animal food produced and of labour employed on average farms in Somersetshire, when compared with the analogous facts in the case of the average farming of Lincolnshire and Norfolk, would afford a still stronger contrast than that which has been already exhibited. It is

certainly not below the truth to estimate the produce of an average Somerset farm (containing a fair proportion of meadow) at about 2½ score, or say half a cwt., of meat per acre, all round; or about 4 score, or say three-quarters of a cwt. per acre, counting only the grass and a moiety of the arable land.

I have it on the authority of several respectable farmers that the amount of money paid in wages on mixed farms is commonly nearer 10*s.* than 20*s.* per acre. The cases in which it exceeds 20*s.* are quite exceptional.

That we have the means in our soil, if we only use them right, of benefiting both the labourer and the farmer, I have not the least doubt, and if the consideration of these facts shall in the slightest degree tend to produce advantage to them, I shall be fully repaid for the trouble of collecting them.

It is admitted that the climate of the south-west of England, especially on and near the hills, is not so favourable to the growth of corn as that of the eastern counties, and, on the other hand, that it is more favourable to the growth of grass. If the farmers in Somersetshire do not keep pace with the arable farmers of the east in the production of stock, to what means will they look to increase the returns of the land?

The attention of the county was publicly drawn to the consideration of this and kindred questions fifty years ago.

Mr. Billingsley concluded his Report with certain practical suggestions; if it seems tedious or trifling to repeat some of them, the best farmers will bear me out in the assertion that there is not one of those which follow but applies in all its force to some part of the county at the present day. I, therefore, shelter myself under his authority, and give them substantially in his own words.

1. Erect proper buildings for the shelter of cattle in the winter months, thereby inviting substantial and well-informed farmers to settle on them.

2. Farmers who have spirit to improve their estates should have some security for being reimbursed.

3. Make as much dung as possible by housing *all sorts of cattle,* preserving urine, collect woollen rags, maltcombs, ashes, horn-shavings, &c.

4. Wherever marl, lime, or chalk can be had within reasonable distance, neglect not a liberal use thereof.

5. Adopt a regular rotation of crops, sow one quarter of turnip land to swedes, sow more sainfoin on the stone-brash.

6. Plough up old mossy hide-bound grass-land.

7. In the west of the county let grass be considered the ultimate object of improvement.

8. Introduce threshing-machines and improved implements

generally; and in order to employ the men in winter, drain wet land, collect manure, &c.

9. When lands are situated on exposed situations, improve the climate by judicious plantations.

To these suggestions I will only venture to add the following inquiries:—

1. Whether a greater quantity of green food might not be constantly produced if the land were kept so clean that the stubbles might be regularly picked over in the autumn and ploughed up for an intermediate winter crop, grown for spring keep, to be followed on the same land by turnips?

2. Whether turnips, as an all but universal rule, might not be put in with superphosphate and a smaller quantity of dung, the spare dung being hauled out on the young grass in the autumn?

3. Whether meat and manure might not be produced in greater quantities and at a cheaper rate by a judicious admixture of roots with other kinds of food, especially chaff and linseed or cake in small quantities, and by greater attention to the time of feeding and the comfort of the animals?

4. Whether young stock ought to be fed merely on straw through the winter, or to receive a small portion of roots and cake regularly, and to be kept in a constantly growing state, so as to come to early maturity?

5. Whether the best way of saving liquid-manure is not to absorb it with ashes in pits, instead of leaving it to run into the pond, or attempting to cart it over in a diluted state?

6. Whether a naked fallow on heavy clays may not be dispensed with, or at least made less frequent, by growing roots with manure as well as seed dibbled, and by using a portable railway to get it off the land?

7. Whether, if the farms on the peat moors were properly arranged, the peat might not be profitably clayed?

Conclusion as to Capital.—The writer who ventures to suggest what is to be done to improve farming in a particular county is bound not to shrink from a practical answer to the question—"*How is it to be done?*" The answer is a very simple one, but I believe it is the only true one:—"By giving encouragement and security to capital." Want of capital is the cause which most retards farming in Somersetshire. There can be no general augmentation of the produce of the land nor of the demand for labour until the capital invested in the farms is larger than it usually is, or the extent of each farmer's land reduced to what he can manage properly.

This can only be the work of time. It implies that landlords shall have learned to resist the temptation of accepting a tenant without capital, because he will give a little more rent than

others, or be content with less outlay on his buildings. It implies that farmers shall have learned to act on the conviction that the occupation of more land demands more stock, more manure, more labour to keep down weeds; and that, if they have not these at command, they will only increase their outgoings and diminish their proportionate receipts.

It may excite the surprise of farmers in other counties that such truisms should be written, but what would they say to the following opinion of a Polden Hill farmer occupying 500 acres of land—half of it in grass, as to the capital required for such a farm, which he plainly thought he was stating high?—"To be sure, a man must have a good bit of money to buy in bullocks for the grass, but not much for the plough-land: we'll say 2000*l.* for the whole." I am convinced that the majority of men enter on farms, having just enough to settle with the outgoing tenant and buy in stock, trusting to the next year's crop for the rent, and to dairy produce and small sales for weekly expenses. The occupation of land by tenants so situated tells heavily on the wages of labour and the poor's-rates, and men of capital feel keenly its indirect effect upon themselves. How much better would it be for all parties if a man worth 1000*l.* would confine himself to an occupation of 100 acres; and if the larger farms were let to men able to farm them well, or even subdivided rather than displace old tenants!

The obvious retort, "Who is to find all the new buildings?" only reveals another tender place, which I will not probe farther, nor will I discuss the abstract question of large and small farms. The farms of the West of England are generally of a moderate size, and nothing would be gained by a change in this respect, provided only, the tenants were generally placed in such circumstances that they might venture to make a judicious expenditure.

The first thing is to remove obstacles to the outlay of capital. A thorough reform in the covenants inserted in leases and agreements is required. In such documents the advice of a practical agriculturist, who understands the climate and habits of the country, but whose judgment has been ripened by extended experience of other districts, is more needed than the common forms of the lawyer. Covenants founded on a dread of exhausting the inherent energies of the soil are out of date. The less a man of capital and integrity is restricted in his mode of cropping the better. Couch soon tells tales.

Enough has been said about the hindrances to farming caused by wet land, needless hedges, and buildings which starve cattle and waste manure. If the landlord cannot advance the money at once for the removal of these hindrances, many tenants would find it for themselves, if they could be secured against the danger of doing injustice to their own families.

Security for the outlay of capital is essential to profitable farming in the present day. It may not be proper to discuss here the means by which this security may best be given. Let it only be remembered that no man can now farm well unless he can look with confidence beyond next Michaelmas. Among good farmers a feeling is now universal, which cannot be better expressed than in the following words of a tenant, who is himself very comfortably situated:—"What we want is any arrangement which will enable us to farm in such a manner that we can give up an estate in good condition without injustice to ourselves or our families."

If I do not close this Report with a formal acknowledgment of the sources from which I have derived my information, it is because the extent of my obligation to others will be transparent to all who are practically acquainted with the subject. I am deeply grateful for the kindness and assistance which I received from many to whom I applied as a stranger; and I only do not name those friends to whom I am especially indebted for their revision of what I have written, lest I should seem to make them responsible for my inferences.

XXXIV.—*Miscellaneous Results from the Laboratory.* By J. Thomas Way, Consulting Chemist to the Society.

(The Members of the Society are informed that no analysis made for them by the chemist of the Society will be published in the Journal unless their sanction to make such use of the results has previously been obtained.)

Refuse Manures.—In a former paper * I published the analysis of some substances which, as the refuse or waste of manufacturing processes, are occasionally employed with great advantage as manure. Of course the supply of this kind of manure is limited, and it is only available in particular localities, and under certain circumstances.

As the value also of refuse substances becomes better known to the farmer, and the demand increases, they will obviously attain a price which will render their purchase less desirable. Still, however, no source of increased fertility, however small, is to be neglected, and a knowledge of the composition, and through it of the manurial value of the different kind of waste products, will not be without a direct benefit.

In recording the analysis of woollen waste in the paper before mentioned, the attention of the reader was called to the great difference existing between the composition of *pure wool* and the

* Journal of the Royal Agricultural Society, vol. x., part ii., page 615.

refuse of the woollen manufacture, which, partaking of its character, might be supposed also to possess somewhat of its value as a manure; and it was showed that nothing but a chemical analysis of the sample itself could enable the farmer to form an opinion of any particular waste substance as manure. These remarks apply with equal truth to the analyses which are now given.

Seal skin.—The skin of the seal is largely used for making caps, tobacco pouches, &c., and the waste pieces which accumulate in considerable quantities are sold at a cheap rate for manure. A sample of this substance was some months ago sent to the laboratory for analysis by the Rev. Mr. Huxtable, and more lately a specimen of the same refuse has been examined for Mr. Paine, of Farnham.

The seal refuse from Mr. Huxtable consisted partly of skin and partly of hair, both of which were very wet.

The hair contained 54·83 per cent. of water. The skin about 60 per cent.

Analyzed for nitrogen they gave respectively, *when dried*:—

The skin	10·53 per cent.
The hair	7·96 ,,

Animal products of this kind possess little or no *mineral* ingredients worthy of mention—their value as manure will, therefore, rest almost exclusively upon the proportion of nitrogen, or, in other words, on the quantity of ammonia which they will ultimately yield to the soil.

The sample of seal skin analysed for Mr. Paine was also very wet; it was mixed apparently with a quantity of sawdust, which, as will be seen, had greatly detracted from its value.

Water in the skin	42·36 per cent.
Nitrogen *on the dried* substance . . .	4·91 ,,

The following are the quantities of nitrogen, or of *ammonia*, which would be furnished by a ton of these three samples in their naturally wet state as purchased:—

	Nitrogen in a ton. lbs.	Ammonia from a ton. lbs.
Skin, 1st specimen	$94\frac{1}{2}$	115
Ditto, 2nd ,, ...	$63\frac{1}{4}$	77
Hair	$80\frac{1}{2}$	98

The price at which this refuse animal matter is to be procured differs from time to time as much or more than its composition. Mr. Huxtable paid, I believe, 16*s*. a ton in London (carriage not included). Mr. Paine informs me that he gave for the quantity he purchased 2*l*. 15*s*. per ton (also without carriage), which he considers too dear in comparison with other manures in the market. "Still," he says, "it told well as a manure for hops."

It is to be borne in mind that manures of an animal nature, particularly when very wet, are often extremely troublesome to deal with. They rapidly run into putrefaction, and it is found impossible to keep them out of the land without great loss and still greater annoyance. In comparing them, therefore, considered as sources of ammonia with ammoniacal salts, guano, and other such manures, a very considerable deduction must on this account be made from the price at which they might otherwise be purchased.

Refuse Horse-hair.—A sample sent to the laboratory by Mr. Paine gave of nitrogen 11·83 per cent., with 4·83 per cent. of ash, which latter was not further examined.

In a ton of the horse-hair we should purchase 265 lbs. of nitrogen, or 322 lbs. of ammonia. The price per ton was 2*l.* 15*s.*, delivered at the railway station in London.

Horn shavings.—These were the refuse shavings and fragments of horns, purchased by Mr. Paine at 7*l.* a ton.

Upon analysis they gave 12·49 per cent. of nitrogen, and their value upon a chemical estimate should be nearly identical with that of hair above. Mr. Paine informs me that he has, both in 1849 and this year, obtained his heaviest crop of hops from the land upon which the horn-shavings were applied.

Feather dust.—This appears to be principally the sweepings of the feather warehouses. Although, apparently, it consists of broken fragments of feathers, it contains so much dirt as greatly to reduce the value as a manure.

The per-centage of nitrogen in this refuse was 6·22, and the price per ton (without carriage) 2*l.* 10*s.*

Scutch.—In a former paper two analyses of this refuse were given—the quantity of nitrogen in them was ·89 and 1·57 respectively. A sample since examined afforded 1·35 per cent. of nitrogen, thus furnishing additional proof that the quantity of animal fertilizing matter in scutch is seldom enough to make it of much value as manure.

Wool refuse.—To the analyses of *shoddy* before given, I have now to add the analyses of three other samples which have been analysed for nitrogen:—

No. 1	contained	of nitrogen	5·21	per cent.
No. 2	,,	,,	3·60	,,
No. 3	,,	,,	4·10	,,

results which accord very nearly with those before recorded.

Another specimen of refuse wool, having evidently a different origin to shoddy, and differing from it in containing very little oil, was analysed for nitrogen, of which it yielded 3·25 per cent. This sample contained 47 per cent. of earthy matter, principally clay and carbonate of lime.

Refuse from a glove-maker's yard.—Some months since a

*Harry Mathews, of Exmoor: a Cart Stallion; bred by Mr. Mitchell, of Week, near Langport.

Thomas Renton, of Otley: a Cart Stallion; bred by Albaney Renton, of Leathley, near Otley.

Samoel and Robert Spencer, of Flicknoe, Warwickshire: a Cart Stallion; bred by Richard Smith, of Draycote, Warwickshire.

William Sherley, of Egham: a Cart Stallion; breeder not known.

N. G. Barthropp, of Cretingham Rookery, Suffolk: a Suffolk Cart Stallion; bred by Mr. Green, of Fingrinhoe, Essex.

*William Giles, of Mark, Somerset: a Roadster Stallion; bred by Charles Howe, of Somerton.

Job White, of Compton Dundon, Somerset: a Norfolk Roadster Stallion; bred by himself.

Lord St. John, of Melchbourne: a Cart Mare and Foal; the mare bred by himself; sire of foal supposed to belong to himself.

*Edmond Wilcox, of Godney, Somerset: a Cart Mare and Foal; the mare bred by himself; sire of foal belonged to Samuel Pennington, of Wells, Somerset.

N. G. Barthropp, of Cretingham Rookery: a Filly; bred by himself.

Sir T. S. Gooch, Bart., of Benacre Hall, Suffolk: a Filly; bred by himself.

*William Fisher Hobbs, of Boxted Lodge, Essex: a Filly; bred by himself.

Charles Newman, of Hayes Court Farm: a Filly; bred by himself, out of a Chestnut Suffolk Mare.

Lord St. John, of Melchbourne: a Filly; bred by himself.

William Sanday, of Holme Pierrepoint: a pen of five Leicester Ewes; bred by himself.

William Sainsbury, of West Lavington: a Southdown Ram; bred by himself.

William Sainsbury, of West Lavington: a Southdown Ram, bred by the late Mr. Beaven, of Gore Farm, Market Lavington.

John Villiers Shelley, of Maresfield Park: a pen of five Southdown Shearling Ewes; bred by himself.

*George Hewer, of Ley Gore, near Northleach: a Cotswold Ram; bred by himself.

Charles Large, of Broadwell: a New Oxfordshire Ram; bred by himself.

William Garne, of Aldsworth: a Cotswold Ram; bred by himself.

William Lane, of Eastington: a Cotswold Ram: bred by himself.

Richard Kinneir, M.D., of Livingshazes, Devon: a pure Berkshire Boar; bred by Robert Peacey, of Chudgloe, Crudwell, Wilts.

*Mark Stainsby, Jun., of Lady Pitt Lane, Leeds: an improved Yorkshire Boar; bred by Lord Wenlock, of Escrick Park.

J. T. Davy, of Rose Ash: a Black Boar of a small breed; bred by himself.

John Hole, of Plymtree, near Collumpton: a Boar; bred by Charles Hole, of Cowley, Middlesex.

James Hardwick, of Willow Farm, Somerset: a Somerset Boar of a small breed; bred by Rev. R. C. Hathaway, of Kewstoke, near Weston-super-Mare.

William Fisher Hobbs, of Boxted Lodge, Essex: two improved Essex Boars; bred by himself.

*Henry Lister Maw, of Tetley, near Crowle: a Boar of a small breed; bred by himself.

*John Savery, of Silverton, Devon: a Boar of a small breed; bred by James Foster, of Woodhouse, near Leeds.

*Joseph Tuley, of Exleyhead: a Boar of a small breed; bred by Thomas Medcalf, of Maddingham, near Bradford.

*Moses Cartwright, of Stanton Hill: a Tamworth Sow; bred by himself.

Moses Cartwright, of Stanton Hill: a Tamworth Sow; bred by himself.

John A. Thomas, of Rose Ash: a Sow of a large breed; bred by himself.

William Ball, of Penzance: a supposed Essex Sow; bred by himself.

*Richard Bartlett, of Lifton, Devon: a Leicester Sow; bred by Francis Rodd, of North Hill, Cornwall.

Frederick Barlow, of Burgh, Suffolk: an Essex Sow; bred by himself.

J. T. Davy, of Rose Ash: a Black Sow of a small breed; bred by R. Mogridge, of Molland.

Richard Mogridge, of Molland: a Molland Sow; bred by himself.

*John Moon, of Lapford, Devon: an improved Essex Sow; bred by himself.

*John F. P. Phillips, of Broomborough, Devon: a Sow of a small breed; bred by himself.

The Earl of Radnor, of Coleshill, Berks: a Coleshill Sow; bred by himself.

*John Savery, of Silverton: a Sow of a small breed; bred by J. R. W. Atkinson, of Leeds.

*Mark Stainsby, jun., of 30, Lady Pitt Lane, Leeds: an improved Leicester Sow; bred by John Mason Hopper, of Newham Grange.

*John Wippell, of Brenton Barton, near Exeter: an improved Devon Sow; bred by himself.

*Joseph Tuley, of Exleyhead: a Sow of a small breed; bred by Mr. Pickard, of Exleyhead, near Keighley.

Joseph Tuley, of Exleyhead: a pen of three Sow Pigs of a large breed; bred by himself.

*G. D. Trotter, of Bishop Middleham: a pen of three Sow Pigs of a large breed; bred by himself.

W. M. Barber, of Langley Broom, Bucks, a pen of three improved Middlesex Sow Pigs; bred by himself.

*John Catherall, of Mold: a pen of three old Sow Pigs of a small breed; bred by himself.

William Fisher Hobbs, of Boxted Lodge: a pen of three improved Essex Sow Pigs; bred by himself.

*Charles Towneley, of Towneley Park, near Burnley, Lancaster: an In-milk Short-horned Heifer; bred by Mr. Bannerman, of Chorley.

*George Coombe, of Creech St. Michael, near Taunton: a pen of Horn Ewes; bred by himself.

*Mark Stainsby, jun., of 30, Lady Pitt Lane, Leeds: a pen of three improved Cleveland Sow Pigs; bred by Thomas Stainsby, of Hunslet.

[These Commendations are arranged in the order of the numbers of the Certificates to which they refer. The mark (*) signifies "highly commended;" the omission of it, "commended;" by the Judges. The mark (**) signifies "very highly commended."]

IMPLEMENTS.

The Award of Prizes and Commendations for Implements at the Exeter Meeting will be found given at length in the Report on the Exhibition and Trial of those Implements, printed in the body of the Journal, vol. xi. part 2, page 487.

Royal Agricultural Society of England.

PRIZES FOR LIVE-STOCK, 1851:

OPEN TO GENERAL COMPETITION.

The Rules of Exhibition, &c., will be advertised at an early date after the Monthly Council in February next.

CATTLE.

Short-horns.

CLASS		
1.	To the owner of the best Bull calved previously to the 1st of January, 1849 . .	Forty Sovereigns.
	To the owner of the second-best ditto ditto	Twenty Sovereigns.
2.	To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old	Twenty-five Sovs.
	To the owner of the second-best ditto ditto	Fifteen Sovereigns.
	To the owner of the third-best ditto . .	Ten Sovereigns.
3.	To the owner of the best Cow in milk or in calf	Twenty Sovereigns.
	To the owner of the second-best ditto ditto	Ten Sovereigns.

[In the case of the cow, to which either of these prizes is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4.	To the owner of the best in-calf Heifer, not exceeding three years old . . .	Twenty Sovereigns.
	To the owner of the second-best ditto ditto	Fifteen Sovereigns.
	To the owner of the third-best ditto . .	Ten Sovereigns.
5.	To the owner of the best Yearling Heifer .	Fifteen Sovereigns.
	To the owner of the second-best ditto .	Ten Sovereigns.
	To the owner of the third-best ditto . .	Five Sovereigns.

Herefords.

1.	To the owner of the best Bull calved previously to the 1st of January, 1849 .	Forty Sovereigns.
	To the owner of the second-best ditto ditto	Twenty Sovereigns.
2.	To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old	Twenty-five Sovs.

CLASS

To the owner of the second-best ditto ditto Fifteen Sovereigns.
To the owner of the third-best ditto . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Twenty Sovereigns.
To the owner of the second-best ditto ditto Ten Sovereigns.

[In the case of the cow, to which either of these prizes is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Twenty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
To the owner of the third-best ditto . . Ten Sovereigns.
5. To the owner of the best Yearling Heifer . Fifteen Sovereigns.
To the owner of the second-best ditto . Ten Sovereigns.
To the owner of the third-best ditto . . Five Sovereigns.

Devons.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . Forty Sovereigns.
To the owner of the second-best ditto ditto Twenty Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Twenty-five Sovs.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
To the owner of the third-best ditto . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Twenty Sovereigns.
To the owner of the second-best ditto ditto . Ten Sovereigns.

[In the case of the cow to which either of these prizes is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Twenty Sovereigns.
To the owner of the second-best ditto ditto Fifteen Sovereigns.
To the owner of the third-best ditto . . Ten Sovereigns.
5. To the owner of the best Yearling Heifer . Fifteen Sovereigns.
To the owner of the second-best ditto . Ten Sovereigns.
To the owner of the third-best ditto . . Five Sovereigns.

Other Breeds:

Not qualified to compete as Short-horns, Herefords, or Devons.
(Cross-bred Animals will be excluded.)

Long-horns.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . . Ten Sovereigns.

sample of animal refuse, obtained as above, was sent to me for examination by Mr. Goodden, of Compton, in Dorsetshire. It was composed of hair, trimmings of sheep, lamb and kid skins, with a quantity of egg-shells, and a large admixture of lime and other earthy matter. Upon analysis it gave—

Water	56·60	per cent.
Animal matter	20·39	„
Carbonate and sulphate of lime, clay, &c.	23·01	„
	100·00	

It contained 1·25 per cent of nitrogen.

The opinion founded upon its composition was not very favourable to this refuse as manure, but Mr. Goodden states that he has used it this year to mangold-wurzel with good effect.

"*Animal Manure.*" *—A cargo of animal refuse was lately brought to this country from Buenos Ayres, and offered for sale under the above title. It appears to consist of the dried up carcasses and bones of animals, from which the fat has been extracted, the largest bones having been subsequently picked out. The fleshy parts are singularly dry and brittle, and easily break down into a coarse powder. The bones are in fragments of various sizes, also particularly dry.

Two specimens of this manure have been analysed in this laboratory—the first for Mr. Hudson of Castleacre; the second for Mr. Purser of the London Manure Company.†

The sample from Mr. Hudson is evidently a tolerably fair average; but that sent by Mr. Purser would afford even more correct results, as to obtain it five tons of the refuse were ground to powder, and perfectly mixed. The following analysis shows the composition of the manure in question—

	From Mr. Hudson.	From Mr. Purser.
Water	6·10	5·57
Animal Matter . . .	53·06	59·53
Sand, &c. . . .	14·41	11·48
Earthy Phosphates . .	22·19	18·01
Nitrogen	6·30	6·59

The manure was offered for sale at, I believe, 5*l*. 10*s*. per ton. Considered as a supply of ammonia and phosphate of lime, its value would be as follows, taking the mean of the two analyses as the basis of the calculation:—Nitrogen, 6·40 per cent., equal to 7·77 of ammonia, or 174 lbs. in a ton, which, at 6*d*. per lb.,

* It exists in heaps of almost unlimited extent, being the remains of cattle slaughtered for their hides, and cattle only. It seems certain to be a most valuable source of ammonia, in addition to guano.—Ph. Pusey.

† Dr. Anderson, of Edinburgh, has also published an analysis of this manure.

would amount to 4*l.* 7*s.*; phosphate of lime, 20·10 per cent., or 450 lbs. in a ton, which, at three farthings per lb., would amount to 1*l.* 8*s.* 2*d.* On this calculation the total value of a ton of the manure would be—

	£.	*s.*	*d.*
For the nitrogen	4	7	0
For the phosphate of lime . .	1	8	2
Total	£5	15	2

We are by no means sufficiently advanced in our knowledge of the action of manures to determine their relative value with great nicety; and however useful in a general way a money test, such as that we have employed above, may be, as a safeguard against serious errors, we must be content at present to allow a considerable latitude for its application in special instances. It will be enough to say that, in reference to other manures, especially Peruvian guano, the price of this "animal manure" has not been chosen far from the mark.* It is greatly to the ultimate interest of the farmer that all attempts to make such sources of manure available should be encouraged; and it is to be hoped that we shall more frequently hear of importations of this kind.

Mr. Hudson, acting upon my advice, has passed five tons of this manure through a riddle. The finer part, consisting of dry flesh with the smaller particles of bones, he has sown for wheat, whilst the larger fragments of bones retained by the screen will be dissolved in acid and kept for the root-crops of next year.

Box-Manure.—The following is the analysis of a sample of manure from the cattle-boxes of Mr. Charles Lawrence, of Cirencester. It need hardly be mentioned that such an analysis only applies with correctness to the sample actually analysed, since the composition of manure from cattle, produced, as it is, from different kinds of food in different proportions, and mixed with more or less of straw, cannot in any two cases be the same. A careful analysis is, however, at all times worth recording.

The sample is from a mixture of the manure of bullocks, horses, and pigs. "The bullocks," says Mr. Lawrence, "were eating mangold and mixed hay and straw chaff, moistened with 4 lbs. of linseed-cake dissolved in boiling water, and 3 lbs. of barley-meal per head per diem. The horses similar chaff, with a bushel of beans and a bushel of oats per head per week. The pigs were fed with mangold and pollard.

The first column of the succeeding table gives the analysis of the *ash* of the manure; the second that of the manure in its natural state.

* Before I had learned at what price the manure was offered for sale, I had advised Mr. Hudson, on the grounds of its chemical composition, not to bring it to a much higher price than 5*l.* a ton.

Analysis of Box Manure.

	Analysis of the Ash.	Analysis of the Manure itself.
Water	..	72·330
Organic Matter	..	21·800
Silica	27·90	1·637
Phosphoric Acid	5·11	·299
Sulphuric Acid	1·11	·065
Carbonic Acid	·95	·055
Lime	14·41	·845
Magnesia	2·40	·110
Oxide of Iron and Alumina	7·81	·458
Potash	11·79	·692
Soda	2·05	·120
Chloride of Sodium	3·82	·224
Sand and Clay	21·80	1·279
	99·15	99·944

The quantity of nitrogen in the manure was found in two experiments to be

1st experiment	·47	per cent.
2nd ,,	·45	,,
Mean ,,	·46	,,

which is equal to ·56 per cent. of ammonia. By distillation of the manure with potash the quantity of ammonia actually existing as such was found to be ·02 per cent., a circumstance which seems to indicate that the fermentation in well ordered boxes is very small.

In the dry manure the straw was separated from the dung by means of a fine sieve, and their relation was found to be as follows:—

Dung	58·3	per cent.
Straw	41·7	,,

Sewer Water.—The sewers of London and other large towns receive the solid and liquid excrements of a large portion of the population—the soapsuds and other waste of the houses, and the waste liquors of all sorts of manufactures—indeed the variety of sources which contribute to the foul current is unlimited. It is the great object of the present system of sewerage, by an abundant supply of water, afforded partly to the houses and partly used for flushing the sewers themselves, to carry down the mass of solid and liquid filth to the nearest outlet by which it may find its way to the great ocean.

Now when it is considered how different is the composition of the food eaten by the various classes of the population; how variously that population is distributed—here a rich square with a limited number of inhabitants—there a squalid and crowded court; when it is remembered that the manufacturing portions

of a city are, for the most part, removed from the residences of the wealthier classes; and further, that the supply of water is generally intermittent, it will be seen that the composition of water taken from any one sewer can only serve to show the general nature of the loss which agriculture sustains from our present system of town sewerage without affording the data by which that loss could be estimated with any degree of accuracy. The following analyses of sewer water will, however, serve to place palpably before the farmer the value of a liquid which (however difficult the problem in cities like London) might certainly with great ease be saved and utilized by many of the moderate-sized towns and larger villages throughout the United Kingdom.

The specimens of sewer water were supplied to me by the Commission of Sewers, at the request of the General Board of Health; they were taken from a sewer in Dorset Square, and another in a place called Barrett's Court. The liquid in both cases was fetid and offensive to the smell, and of a dirty black colour; sulphuretted hydrogen gas was given off from it in sensible quantity.

The matter in suspension and that in solution were separately analyzed—the following was the quantity of each in an imperial gallon of the specimens:—

No. 1.—Sewer Water from Barrett's Court.

An imperial gallon contained—

Of substances in solution . . .	243·30 grains.
Of insoluble substances . . .	248·96 „

No. 2.—Sewer Water from Dorset Square.

The imperial gallon contained—

Of substances in solution . . .	109·00 grains.
Of insoluble substances . . .	100·70 „

The insoluble matter, as will be seen, consisted partly of sand and the dust of the granite or other paving—the organic portion contained the cells of different vegetables, hair, fragments of paper, &c.

The following tables give the composition of the liquid and solid matter of these specimens of sewer water:—

The insoluble and soluble matters are both capable of supplying nitrogen or ammonia to vegetation. The solution contains the nitrogen in the form of ammoniacal salts, and it is a circumstance of great interest and practical importance that *all the nitrogen* in the liquid state seems to be in the form of ammoniacal salts—the urea and other animal products having rapidly passed into this condition. The insoluble matter contains, of course, no ammoniacal salts, its nitrogen being referable to unchanged animal matters. The quantity of ammonia in the soluble and insoluble state in a gallon of sewer water, calculating the nitrogen

CLASS

2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

[In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . Five Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

CHANNEL ISLANDS' BREED.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

[In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . Five Sovereigns.
5. To the owner of the best Yearling Heifer Five Sovereigns.

SUSSEX BREED.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

[In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . Five Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

SCOTCH HORNED CATTLE.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.

CLASS

3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

 [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Ten Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

SCOTCH POLLED CATTLE.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

 [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Ten Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

WELSH, IRISH, AND OTHER PURE BREEDS.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

 [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Five Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

HORSES.

1. To the owner of the best Stallion for Agricultural Purposes, of any age . . . Thirty Sovereigns.
 To the owner of the second-best ditto ditto . Fifteen Sovereigns.
2. To the owner of the best two years-old Stallion for Agricultural Purposes . . Twenty Sovereigns.

CLASS

	To the owner of the second-best ditto ditto.	Fifteen Sovereigns.
	To the owner of the third-best ditto ditto	Ten Sovereigns.
3.	To the owner of the best Stallion for Dray Purposes	Twenty Sovereigns.
4.	To the owner of the best Stallion for getting Hunters	Thirty Sovereigns.
5.	To the owner of the best Stallion for getting Carriage Horses	Thirty Sovereigns.
6.	To the owner of the best Stallion for getting Roadsters	Fifteen Sovereigns.
7.	To the owner of the best Mare and Foal for Agricultural Purposes	Twenty Sovereigns.
	To the owner of the second-best ditto ditto.	Fifteen Sovereigns.
	To the owner of the third-best ditto ditto	Ten Sovereigns.
8.	To the owner of the best two years-old Filly for Agricultural Purposes	Twenty Sovereigns.
	To the owner of the second-best ditto ditto.	Fifteen Sovereigns.
	To the owner of the third-best ditto ditto	Five Sovereigns.

SHEEP.

Leicesters.

1.	To the owner of the best Shearling Ram	Thirty-five Sovs.
	To the owner of the second-best ditto.	Twenty Sovereigns.
	To the owner of the third-best ditto	Ten Sovereigns.
2.	To the owner of the best Ram of any other age	Thirty Sovereigns.
	To the owner of the second-best ditto.	Twenty Sovereigns.
	To the owner of the third-best ditto	Ten Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes of the same flock	Twenty Sovereigns.
	To the owner of the second-best ditto ditto	Fifteen Sovereigns.
	To the owner of the third-best ditto ditto	Ten Sovereigns.

South-Down, or other Short-woolled Sheep.

1.	To the owner of the best Shearling Ram	Thirty-five Sovs.
	To the owner of the second-best ditto.	Twenty Sovereigns.
	To the owner of the third-best ditto	Ten Sovereigns.
2.	To the owner of the best Ram of any other age	Thirty Sovereigns.
	To the owner of the second-best ditto.	Twenty Sovereigns.
	To the owner of the third-best ditto	Ten Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes of the same flock	Twenty Sovereigns.
	To the owner of the second-best ditto ditto.	Fifteen Sovereigns.
	To the owner of the third-best ditto ditto	Ten Sovereigns.

Long-woolled Sheep:

Not qualified to compete as Leicesters.

CLASS		
1.	To the owner of the best Shearling Ram .	Twenty-five Sovs.
	To the owner of the second-best ditto .	Fifteen Sovereigns.
2.	To the owner of the best Ram of any other age	Twenty Sovereigns.
	To the owner of the second-best ditto .	Ten Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes of the same flock . . .	Ten Sovereigns.
	To the owner of the second-best ditto .	Five Sovereigns.

Sheep best adapted to a Mountain District:

Not qualified to compete as South-downs.

1.	To the owner of the best Ram of any age .	Twenty Sovereigns.
	To the owner of the second-best ditto .	Ten Sovereigns.
2.	To the owner of the best pen of Five Shearling Ewes	Ten Sovereigns.
3.	To the owner of the best pen of Ewes of any age	Ten Sovereigns.

PIGS.

1.	To the owner of the best Boar of a large breed	Fifteen Sovereigns.
	To the owner of the second-best ditto ditto .	Ten Sovereigns.
	To the owner of the third-best ditto ditto .	Five Sovereigns.
2.	To the owner of the best Boar of a small breed	Fifteen Sovereigns.
	To the owner of the second-best ditto ditto .	Ten Sovereigns.
	To the owner of the third-best ditto ditto .	Five Sovereigns.
3.	To the owner of the best Breeding Sow of a large breed	Fifteen Sovereigns.
	To the owner of the second-best ditto ditto .	Five Sovereigns.
4.	To the owner of the best Breeding Sow of a small breed	Fifteen Sovereigns.
	To the owner of the second-best ditto ditto .	Five Sovereigns.
5.	To the owner of the best pen of three Breeding Sow-Pigs of a large breed, of the same litter, above four and under eight months old	Ten Sovereigns.
	To the owner of the second-best ditto ditto .	Five Sovereigns.
6.	To the owner of the best pen of three Breeding Sow-Pigs of a small breed, of the same litter, above four and under eight months old	Ten Sovereigns.
	To the owner of the second-best ditto ditto .	Five Sovereigns.

By order of the Council,

James Hudson, *Secretary*.

London, December 12, 1850.

of the solid matter as if it had passed into ammonia, is as follows:—

Ammonia in a gallon—
In the soluble state . . . . 36·72 grains.
In the insoluble state . . . . 4·56 „

Analysis of Sewer Water.—No. 1. From Barrett's Court.

	An Imperial Gallon contains (in grains and tenths)—		
	Soluble.	Insoluble.	Both.
Organic Matter and Salts of Ammonia . . .	121·50	180·32	301·82
Sand and Detritus of the Granite from the Streets	*1·31	19·29	20·60
Soluble Silica	1·57	10·94	12·51
Phosphoric Acid	7·71	2·73	10·44
Sulphuric Acid	10·71	4·02	14·73
Carbonic Acid	11·62	3·97	15·59
Lime	7·50	17·03	24·53
Magnesia	2·87	Traces.	2·87
Peroxide of Iron and Alumina	Traces.	6·20	6·20
Potash	16·91	1·22	18·13
Soda		1·51	1·51
Chloride of Potassium			
Chloride of Sodium	31·52	1·72	33·24
	243·70	218·56	462·26

Analysis of Sewer Water.—No. 2. From Dorset Square.

	An Imperial Gallon contains (in grains and tenths)—		
	Soluble.	Insoluble.	Both.
Organic Matter and Salts of Ammonia . . .	57·32	23·00	80·32
Sand and Detritus of the Granite from the Streets	0·79	44·50	45·29
Soluble Silica	1·16	12·09	13·25
Phosphoric Acid	2·53	1·64	4·17
Sulphuric Acid	0·28	3·63	3·91
Carbonic Acid	10·58	1·99	12·57
Lime	7·40	8·37	15·77
Magnesia	·07	Trace.	·07
Peroxide of Iron and Alumina	Trace.	2·66	2·66
Potash	2·60	0·72	3·32
Soda			
Chloride of Potassium			
Chloride of Sodium	27·27	2·10	29·37
	109·00	100·70	209·70

Ammonia:—
In the soluble state . . . . . 15·16 grains.
To be formed from the insoluble matter . 2·80 „

---

* This is some small proportion of insoluble matter escaping the linen filter, and properly belonging to the other column.

It will be observed that the water from Dorset Square contains less than one-half the quantity of soluble and insoluble matters found in the other specimens, and the quantity of ammonia and phosphoric acid are in the same proportion. The first sample, however, contains a wonderful excess of potash—a circumstance not easily accounted for—I have reason to believe, however, that it is in great measure due to the influx of water from the streets which, under certain circumstances, is highly charged with salts of potash derived from the granite.

For the sake of illustration, we may be allowed, perhaps, to calculate the money value of the ammonia and phosphoric acid alone of the poorest of these samples of sewer water—remembering always that the least important of the ingredients would have a value, when the immense quantity of material we have to deal with is considered. Ten thousand gallons of sewer water, No. 2, would contain 179,600 grains of ammonia, or rather more than $25\frac{1}{2}$ lbs.; and 41,700 grs. of phosphoric acid, equal to 86,000 grs. of phosphate of lime, or about 12 lbs. The united value of these two substances—ammonia being taken at 6*d.* and phosphate of lime at $\frac{3}{4}$*d.* per lb., would be about 13*s.* 6*d.*; 100,000 gallons would have a value of 6*l.* 15*s.*; or a million gallons of 67*l.* 10*s.* The quantity of water supplied to London daily (and running away therefore in the sewers) is said to exceed 40 million gallons. Let us suppose that the ammonia and phosphoric acid alone of a million gallons of the sewage are worth 50*l.*, and we have a daily sum of 2000*l.* swept into the Thames, or nearly three quarters of a million each year. It is curious that the yearly expense which is incurred by the farmers of England in the importation of guano to make good this loss, would amount to a somewhat similar sum. There is no kind of doubt that, agriculturally considered, the sewage is more than worth this sum, since the Belgians, who take great care of human manure, consider the excreta of each person worth more than 1*l.* per annum, and the population of London exceeds $2\frac{1}{4}$ millions.

The calculations here given must be looked upon, as we before said, merely as an expression of the great agricultural value of the sewer water of towns, and not as an attempt to fix that value with any approximation even to the truth.

END OF VOL. XI.

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Royal Agricultural Society of England.

1849—1850.

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Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Saturday, Dec. 15, 1849.

REPORT OF THE COUNCIL.

The Council have to make the following Report to the Members of the Society on the occasion of their present General Meeting.

During the past-half-year 2 Governors and 189 Members have been elected, 3 Governors and 71 Members have died, and the names of 4 Governors and 236 Members have been removed from the list. The Society now consists of the following numbers:—

90 Life Governors,
173 Annual Governors,
607 Life Members,
4499 Annual Members, and
19 Honorary Members,

making a total of 5388 Members. This total amount, being 124 less than at the former General Meeting, does not indicate so much a reduction in the actual Members of the Society as a removal of those names from the list which were put down for temporary and local purposes only, at the early Country Meetings of the Society; the new Members now joining the Society consisting of those steady friends to agricultural improvement, who, on higher grounds, take a permanent interest in the advancement of its objects, and in its continued prosperity.

The Council have directed a new list of the Governors and Members of the Society to be printed and published as an Appendix to the ensuing part of the Journal.

Among the deaths recorded, the Council regret to specify that of their venerable Member, Mr. Hillyard, one of the founders of the Society, and a constant attendant, to within a very short period of his decease, at their various meetings. The Council have filled up the vacancy in their body, occasioned by his lamented loss, by the election of Mr. Sillifant. They have also elected Mr. Simpson a Member of Council, in the place of the Earl of Lovelace (whose present engagements prevent his due attendance), and Lord Camoys a Member of their body, in the place of the late Mr. Umbers.

The Council reported at the General Meeting in May, last year, that they had altered the by-law regulating the week-day of their ordinary meetings from Wednesday to Tuesday; they have, however, after experience of that change, decided to revert, after the end of the current year, to the original day for their meetings, namely, to the Wednesday, as more generally convenient to all parties.

Finances.—The Council have had under their most serious consideration the question they have been so often under the painful necessity of bringing under the notice of the Members, namely, that of the arrears of subscription remaining unpaid to the Society. The Council have taken every ordinary means in their power to awaken the Members, from whom these arrears are due, to a sense of their engagements to the Society, by repeated circular letters, by an attempted system of local collection, by personal communications kindly made to the parties by zealous Members of the Council, by suspension of their names in the public Council-room, and in some cases by application made to them by the solicitors of the Society. These means having proved successful only to a certain extent, the Council have requested a scrutiny to be made into the circumstances of the individuals who thus neglect to comply with the just claims of the Society; and they find that no plea, in the great majority of the

cases, can be set up on the ground of inability to discharge their obligations—a plea to which the Council have always most considerately attended in the case of those Members who, from adverse circumstances, have unfortunately been unable to meet even the small demands of the Society. The Council have never for an instant doubted, under all this forbearance, the just and legal claim the charter of the Society gave them to recover these arrears in a court of law; but thinking that many of the defaulters might regard the payments due from them as simply optional, like those of an unchartered club or association, held together by motives merely of personal convenience, and with advantages enjoyed only while the voluntary subscription is yearly paid, they conceived that the opinion of eminent counsel on this point, if obtained and transmitted to them, would at once remove such doubts, and lead to the instant payment of the arrears due. Accordingly, such legal opinion was obtained from Sir Frederick Thesiger and Mr. Warren, in the following terms, and a copy of it addressed in a letter by the Chairman of the Finance Committee to each Member in arrear, namely:—

"We can see no difficulty whatever in this case. No member of the Society can legally cease to be such, simply by discontinuing the payment of his subscription. By so doing he may disentitle himself to the privileges of the Society, but unquestionably remains liable to pay all arrears of subscription which may be due, till he shall have legally withdrawn from the Society in the manner provided for in the bye-laws. The subscriptions are by no means voluntary donations, but legal dues, and, as such, legally recoverable by the Secretary for the use of the Society. Every Member is clearly apprised of his legal liabilities by the circular sent to him, announcing his election. We are therefore of opinion that none of the grounds suggested in the case are available for resisting payment of the subscriptions in arrear.

(Signed) "Frederick Thesiger.
"Samuel Warren.

"*Inner Temple*, *May* 7, 1849."

Of the parties thus addressed only about one-half favoured the Chairman with an answer, either by paying the arrears or entering into explanations by way of extenuation of claim; while the

other half, to the present time, have refused him the ordinary courtesy of a reply. Under these circumstances the Council feel that their duty to the Society places them under the painful necessity of resorting to the extreme measure of enforcing these payments by process issued from the County Courts in their district throughout the kingdom, against all Members who are more than two years in arrear; and they have accordingly directed their Secretary to address a letter to all such Members, informing them that unless the sums due are paid to him by Post-office order, or otherwise, on or before the 1st of February next, immediate steps will be taken, without further notice, to recover such sums in the County Court of the district wherein they respectively reside. The Council have instructed the Finance Committee to proceed in each case in such order as they may determine, and to report at each Monthly Council the proceedings taken in furtherance of this order. When it is considered that the admission of Members into the Society is made by voluntary request on their part, and that provision has constantly to be made in advance, by the outlay of a considerable amount of money, to meet and supply their privileges, the Council feel assured that the Members of the Society will think they have only done their duty to the body at large by enforcing the regulations against those non-contributing Members, and by bringing to a final issue this long-pending and agitated question of arrears; thus reducing the Society to an efficient body of contributing Members, and rendering the income of the Society a definite and legitimate amount, instead of its being as at present, from the obstacle of the arrears, a loose estimate, founded on vague probabilities and unsettled claims.

Country Meetings.—The Norwich Meeting of this year has proved eminently successful, in the amount and character of the live stock and implements, as well as in all the arrangements connected with their conveyance and exhibition. The Society are indebted to Mr. Thompson for a Report on the Exhibition and Trial of the Implements at Norwich, which will appear in the ensuing number of the Society's Journal. His period of office,

as one of the stewards of the implement-yard at the Society's Country Meetings, expired at the close of the Norwich Meeting, when he went out by rotation as senior steward, the vacancy being filled up by the appointment of Sir Matthew White Ridley as junior steward of that department, who has accepted that office. On the motion of the Honourable Captain Dudley Pelham, the Council have resolved in future to appoint a steward-elect of implements, who being nominated a year in advance of that in which he comes into actual office, will have the opportunity of qualifying himself by attendance at the steward's departments, and careful examination into the numerous details and duties of his office, for the actual duties he will have himself to perform, and the operations he will have to superintend and direct, when he comes into office by rotation in the following year. The Council are assured that this important preliminary qualification will render the duties performed by the stewards more valuable to the Society, whilst they will be more easy and satisfactory to themselves. The means for testing the power given off by agricultural machinery having this year been perfected in so striking and satisfactory a manner by the consulting-engineer, Mr. Amos (of the firm of Easton and Amos), as to render what had been previously a laborious and uncertain task nothing more than a simple registration of facts, or mechanical results, alike convincing to the Judges and to the implement-makers themselves, the Council, on the recommendation of the stewards, decided to present to Mr. Amos, the Gold Medal of the Society for having effected this important object. The Council before leaving Norwich conveyed to the Mayor and Corporation of that city, to the Local Committee, and to the owners and occupiers of sites of ground, as well as to the various other parties, who had so zealously co-operated with them on the occasion, their cordial thanks for the kind attention they had paid to the wishes of the Society, and the admirable manner in which they had made every arrangement required of them for promoting the success of the Meeting. The Society were also especially indebted to the various railway companies for the great privileges and facilities

they afforded to the Society's exhibitors, and particularly to the Eastern Counties Company for the great attention paid by them to the local requirements of the occasion.

The Council have fixed the period for the Exeter Meeting as the week commencing Monday, the 15th of July—Thursday being, as usual, the principal day of the Show. They have also determined the Prizes to be offered for that Meeting, and the various terms and conditions connected with the competition, all of which will be found detailed in the Prize-sheets printed for the occasion, and to be obtained on application to the Secretary. They have decided not to have a Council Dinner at Exeter, but to have a Pavilion Dinner to accommodate 900 guests. They have resolved that the Judges of Stock shall be requested to commence their duties at six o'clock on the Wednesday morning, instead of nine o'clock, in order that admission may be given to inspect the stock on that day by one o'clock in the afternoon, or as soon after as the Judges may have delivered in their awards.

Lectures and Chemical Investigations.—The Society at the Norwich Meeting were favoured by Professor Simonds and the Rev. Edward Sidney with valuable lectures, which will appear, with interesting illustrations, in the ensuing number of the Society's Journal. To Professor Simonds and Professor Way they have also been indebted, at the present Meeting in London, for the delivery of valuable lectures on topics of scientific and practical interest to the farmer. Agreeably with the arrangement made with Professor Way, as the Consulting Chemist to the Society, important chemical investigations are in active progress in his laboratory; of these some of the results will be given in the next part of the Journal. He has also kindly offered to deliver before the Council, after each of their Weekly Meetings, during the ensuing Spring, a course of twelve familiar chemical lectures, on topics of practical interest, and elucidated by experiments.

Veterinary Inspection. — The Council have received and adopted the following Report from their Veterinary Committee :—

"REPORT OF THE VETERINARY COMMITTEE.

"With a view to the collecting and perpetuating a body of authentic information in regard to the diseases of cattle, sheep, and pigs, and arresting their progress, the Society appoints a professional Inspector for these purposes. Any Member of the Society who may desire a competent professional opinion and advice in cases of extensive or destructive disease among his stock, and will address himself by letter to the Secretary, will, by return of post, receive a printed list of queries, which he is requested to fill up and return immediately. On the receipt of such returned list the Secretary will convene the Veterinary Committee forthwith (two Members of which, with the assistance of the Secretary, shall be competent to act); and such Committee will decide on the necessity of despatching the Society's Inspector to the spot where disease prevails. The remuneration of such Inspector shall be a professional fee of 2*l.* 2*s.* per diem, and 1*l.* 1*s.* per diem for personal expenses; and he shall also charge the cost of travelling to and from the localities where his services may have been required. The fees will be paid by the Society, but the travelling expenses will be a charge against the applicant for professional aid. This charge may, however, be commuted or remitted altogether at the discretion of the Council, on such step being recommended by the Veterinary Committee.

"The Inspector, on his return from visiting the diseased stock, shall report to the Committee, in writing, the results of his observations and proceedings, which Report will be laid before the Council.

"When contingencies arise that may prevent a personal discharge of the duties confided to the Inspector, he may, subject to the approval of the Committee, name some competent professional person to act in his stead, who shall receive the same rates of remuneration.

"(Signed) THOMAS RAYMOND BARKER, Chairman."

The Council have received with much satisfaction the cordial acquiescence of the Governors of the Royal Veterinary College in the request made to them by the Council that Professor Simonds should be allowed to act as the Veterinary Inspector of the Society.

Farm Accounts.—The Society having offered, in 1846, a prize of 10*l.* for the best Essay on Keeping Farm Accounts, the Council reported to the May General Meeting in that year in the following terms:—"The Judges on the Sixteen Essays on the Keeping of Farm Accounts, having reported that none of the Essays are

worthy of the prize offered by the Society in that class, the Council appointed a Committee to report on the best mode, in their opinion, in which a practical farmer may be enabled, in the simplest manner, to keep the requisite accounts connected with his farming establishment." The Committee having taken that important practical question into their mature consideration, and having examined the various forms transmitted at different times to the Library of the Society, have laid before the Council the forms of accounts proposed by them for adoption. These forms having been sent round to each Member of the Council, inviting their comments and suggestions, the Council took such communications into their consideration, and finally agreed to adopt the forms proposed, subject to certain alterations of headings and rulings, and conditionally that a statement should be inserted in the principal book (to be sold with the others at a reduced price to the Members of the Society), that they were submitted to their notice only for present adoption, in the hope that such suggestions would be offered to the Council by practical men who might use them as might tend to their further improvement. The Council are fully aware that forms of accounts of any kind must be adapted to the different capacities or habits of business of those who are to use them, and bear a reference to the farmer's extent of occupation. They accordingly put forth these forms of accounts more as further means for improvement to be derived from experience of their practical use, than as offering them to the agricultural world as an exact or universal model by which all farm accounts are to be kept. They conceive the experience thus gained, and the simple fact of impressing upon farmers the necessity of keeping accurate records of outlay and income, and of profit and loss, in the several departments of their farming, will in itself be a great step towards that desired end. The habit of exact registration thus acquired in their money transactions will also extend to other objects, especially to that journalising of daily occurrences and operations on their farms which will become to them a valuable historical record for detecting the cause of failure or success in any particular mode of cultivation

they may adopt, and thus furnish them with useful direction for future guidance.

Cottages and Farm-buildings.—The Society have been much favoured by his Grace the Duke of Bedford, with a valuable contribution to their Journal, on the subject of labourers' cottages; and they are also indebted to Mr. Spooner (and Mr. John Elliott), Mr. Sturgess, Mr. Ewart, and Mr. Tebbutt, the authors of the Essays on Farm-buildings commended by the Judges, for the kind manner in which they have placed their respective Essays at the disposal of the Journal Committee for publication.

Collection of Wheats.—Mr Brandreth has reported to the Council the completion of the arrangements he had undertaken, at the request of the House Committee, respecting the collection of wheats presented to the Society by Miss Molesworth, Colonel Le Couteur, and the Rev. Professor Henslow. These specimens have been carefully arranged in guard-books, and placed in a cabinet prepared for their reception in the Council-room, for the ready access and convenient inspection of Members of the Society; space having been purposely left in the guard-books for the insertion of further specimens, and in the catalogue for their due registration.

The Council congratulate the Society on the improvements successively made each year in the various departments of its operations, and on the general recognition of the value of its influence in animating and sustaining the cause of practical farming; and they cannot entertain a doubt that, by the united exertions of all parties connected with agriculture, such a progressive improvement will be made in the cultivation of the soil, and the economy of British husbandry, as will promote the greatest production at the least cost, and thus be found contributing to the mutual interest of the parties more immediately concerned, and to the increased resources of the country.

By order of the Council,

(Signed) JAMES HUDSON,

Secretary.

London, 14th December, 1849.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending 30th June, 1849.

Receipts.	£.	s.	d.
Balance in the hands of the Bankers, December 31, 1848	588	7	1
Ditto in the hands of the Secretary, December 31, 1848	10	3	5
Dividends on Stock	140	4	7
Life Composition of Governor	40	0	0
Life Compositions of Members	280	0	0
Annual Subscriptions of Governors	595	5	0
Annual Subscriptions of Members	2922	12	0
Sale of Journal	153	12	6
Subscription from Norwich towards the expenses of the Country Meeting of 1849	1000	0	0
Other Receipts on account of the Country Meetings	10	13	6
Amount of Sums paid in error, or by parties unknown, to the Society's account with their Bankers	10	0	0
	£5750	18	1

Payments.	£.	s.	d.
Permanent Charges	170	12	6
Taxes and Rates	14	16	2
Establishment	742	19	7
Postage and Carriage	17	16	0
Advertisements	10	5	6
Expenses of Journal	1594	15	6
Prizes	310	0	0
Payments during the half-year on account of the Country Meetings	907	19	11
Analysis of Ashes of Plants	100	0	0
Repayment of Sums transmitted by Bankers and others in error	19	1	0
Amount of Miscellaneous Items of Petty Cash	3	11	2
Balance in the hands of the Bankers, 30th June, 1849	1825	15	11
Ditto in the hands of the Secretary, 30th June, 1849	3	4	0
	£5750	18	1

(Signed) C. B. CHALLONER, *Chairman*,
THOMAS AUSTEN,
THOMAS RAYMOND BARKER, } *Finance Committee.*

Examined, audited, and found correct, this 14th day of December, 1849.

(Signed) THOMAS KNIGHT,
ROBERT BEMAN,
JOHN BELL CROMPTON, } *Auditors on the par of the Society.*

SPECIAL COUNTRY MEETING ACCOUNT: NORWICH, 1849.

Note.—The sum of £[illegible], as the amount of Prizes awarded by the Society in the year 1849, is not included in this Special Account as an expense attending the Norwich Meeting, but is made chargeable in the General Account as a payment out of the common Funds of the Society.

RECEIPTS.	£.	s.	d.
Subscription from Norwich	1000	0	0
Council Dinner Tickets	187	0	0
Pavilion Dinner Tickets	328	0	0
Show-yard Receipts	2104	16	1
Sale of Catalogues	325	18	0
Sale of Council Badges	5	0	0
Sale of Wheat	93	18	11
Excess of Payments over Receipts on account of the Norwich Meeting, chargeable on the general Funds of the Society	6	17	4
	£4351	10	4

PAYMENTS.	£.	s.	d.
Council Dinner	207	11	2
Great Dinner	317	7	7
Show-yard and Trial of Implements	2779	13	11
London Police	118	1	0
Judges	296	0	0
Consulting Engineer	66	7	1
Printing, Paper, and Stitching of Catalogues	266	11	3
Printing for the general purposes of the Meeting	86	12	6
Stationery	1	13	4
Advertisements	100	4	0
Postage, Carriage, and Travelling Expenses	40	12	0
Official Staff Charges	13	12	6
Porters in Charge of Rooms	3	3	0
Council Badges	2	16	6
Surveyor's Plans	5	5	0
Extra Clerks	2	2	0
Fittings for Lectures in County Court	10	4	0
Fitting Town-Hall as Offices	1	10	0
Bill Posters, Messengers, &c.	2	3	3
	£4351	10	4

(Signed) C. B. CHALLONER,
Chairman Finance Committee.

Country Meeting at Norwich.

PRINCIPAL DAY OF THE SHOW, THURSDAY, JULY 19, 1849.

LIST OF JUDGES.

Short Horns.	Thomas Parkinson	Leyfields, Nottinghamshire.
	George Dale Trotter	Bishop Middleham, Durham.
	Samuel Bennett	Bickerings Park, Bedfordshire.
Herefords, Devons, and other Breeds.	Richard Milward	Thurgarton Priory, Nottinghamshire.
	Henry Chamberlain	Desford, Leicestershire.
	Henry Higgins	Brinsop Court, Herefordshire.
Horses.	William C. Spooner	Southampton, Hampshire.
	William Greaves	Matlock-Bath, Derbyshire.
	Thomas Knight	Ringmer, Sussex.
Leicester Sheep.	Joseph Allison	Bilby, Nottinghamshire.
	Wm. Bartholomew	Goltho, Lincolnshire.
	Nathaniel C. Stone	Rowley Fields, Leicestershire.
South-Down Sheep.	Edward Pope	Great Toller, Dorsetshire.
	Robert Boys	Eastbourne, Sussex.
	Edward Trumper	Nuneham, Oxfordshire.
Long-Woolled Sheep.	Robert Beman	Moreton-in-the-Marsh, Gloucestershire.
	Edward Clarke	Canwick, Lincolnshire.
	Henry Bateman	Asthally, Oxfordshire.
Pigs.	John Clayden	Littlebury, Essex.
	William Hesseltine	Worlaby House, Lincolnshire.
	William Gillett	Southleigh, Oxfordshire.

Implements.	William N. Parsson	Gravel Lane, Southwark, Surrey.
	Charles John Carr	Belper, Derbyshire.
	William Lister	Dunsa Banks, Yorkshire.
	Henry Taylor	Dilham, Norfolk.
	Owen Wallis	Overstone Grange, Northamptonshire.
	William Shaw	Far-Coton, Northamptonshire.
	Thomas Hawkins	Assington Moor, Suffolk.
	Peter Love	Naseby, Northamptonshire.
	Thomas W. Granger	Stretham Grange, Cambridgeshire.
	James Hale Nalder	Alvescot, Gloucestershire.

Consulting Engineer—Charles Edwards Amos (of the Firm of Easton and Amos), The Grove, Southwark, Surrey.

AWARD OF PRIZES.

CATTLE: I. *Short-Horns.**

WILLIAM TOD, of Elphinstone Tower, near Tranent, N. B.: the Prize of FORTY SOVEREIGNS, for his 4 years and 1 month-old Short-horned Bull; bred by the Duke of Buccleugh, of Dalkeith, N. B.

THOMAS SPORE ATKINS, of Kimberley, near Wymondham, Norfolk: the Prize of TWENTY SOVEREIGNS, for his 5 years and 4 months-old Short-horned Bull; breeder unknown.

RICHARD BOOTH, of Warlaby, near Northallerton, Yorkshire: the Prize of TWENTY SOVEREIGNS, for his 3 years and 4 months-old Short-horned in-milk Cow; bred by himself.

RICHARD BOOTH, of Warlaby, near Northallerton, Yorkshire: the Prize of TEN SOVEREIGNS, for his 4 years and 4 months-old Short-horned in-milk and in-calf Cow; bred by himself.

JOHN KIRKHAM, of Hagnaby, near Spilsby, Lincolnshire: the Prize of TWENTY SOVEREIGNS, for his 3 months, 3 weeks, and 3 days-old Short-horned in-calf Heifer; bred by himself.

WILLIAM FOWLE, of Market Lavington, near Devizes, Wiltshire: the Prize of TEN SOVEREIGNS, for his 2 years and 5 months-old pure Short-horned in-calf Heifer; bred by himself.

BENJAMIN WILSON, of Brawith, near Thirsk, Yorkshire: the Prize of TEN SOVEREIGNS, for his 1 year and 8 days-old Short-horned yearling Heifer; bred by himself.

CHARLES TOWNELEY, of Towneley Hall, near Burnley, Lancashire: the Prize of FIVE SOVEREIGNS, for his 1 year and 10 months-old pure Short-horned Yearling Heifer; bred by Alexander Bannerman, of Chorley, Lancashire.

CATTLE: II. *Herefords.*

EDWARD PRICE, of the Courthouse, Pembridge, near Leominster, Herefordshire: the Prize of FORTY SOVEREIGNS, for his 4 years, 5 months, and 20 days-old Hereford Bull: bred by David Williams, of Newton, near Brecon, S. W.

WILLIAM HEWER, of Hill Farm, Northleach, Gloucestershire: the Prize of TWENTY SOVEREIGNS, for his 9 years and 5 months-old Hereford Bull; bred by himself.

* The Judges decided not to award any Prizes in Class II. (that of Bulls calved since the 1st of January, 1847, and more than 1 year old), on account of the absence of merit which, in their opinion, prevailed in the animals shown in that class for the Prizes of the Society.

Edward Price, of the Courthouse, Pembridge, near Leominster, Herefordshire: the Prize of Twenty Sovereigns, for his 1 year and 5 months-old Hereford Bull; bred by himself.

William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: the Prize of Ten Sovereigns, for his 2 years, 3 months, and 21 days-old Hereford Bull; bred by himself.

John Walker, of Westfield House, Holmer, near Hereford: the Prize of Twenty Sovereigns, for his 3 years and 4 months-old Hereford in-milk and in-calf Cow; bred by John Carpenter, of Eardisland, near Leominster, Herefordshire.

William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: the Prize of Ten Sovereigns, for his 6 years-old pure Hereford in-calf and in-milk Cow; bred by William Pratt, of Long Itchington, near Southam, Warwickshire, from the stock of the late John Price, of Poole House, near Upton-on-Severn, Worcestershire.

The Rev. John Robert Smythies, of East Hill, near Colchester, Essex: the Prize of Twenty Sovereigns, for his 2 years and 6 months-old Hereford in-calf Heifer; bred by Samuel Aston, of Lynch Court, Herefordshire.

The Rev. John Robert Smythies, of East Hill, near Colchester, Essex: the Prize of Ten Sovereigns, for his 2 years and 4 months-old Hereford in-calf Heifer; bred by Samuel Aston, of Lynch Court, Herefordshire.

Lord Berwick, of Cronkhill, near Shrewsbury: the Prize of Ten Sovereigns, for his 1 year and 9 months-old Hereford Yearling Heifer; bred by himself.

George Pitt, of Wellington, near Hereford: the Prize of Five Sovereigns, for his 1 year and 5 months-old Hereford Yearling Heifer; bred by himself.

Cattle: III. *Devons.*

James Quartly, of Molland, near South Molton, Devonshire: the Prize of Forty Sovereigns, for his 3 years and 6 months-old North Devon Bull; bred by himself.

Samuel Farthing, of Nether Stowey, near Bridgwater, Somersetshire: the Prize of Twenty Sovereigns, for his 2 years and 7 months-old pure Devon Bull; bred by himself.

William M. Gibbs, of Bishop's Lydeard, near Taunton, Somersetshire: the Prize of Twenty Sovereigns, for his 1 year and 8 months-old Devon Bull; bred by himself.

The Earl of Leicester, of Holkham Hall, near Wells-next-the-Sea, Norfolk: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Devon Bull; bred by himself.

The EARL OF LEICESTER, of Holkham Hall, near Wells-next-the-Sea, Norfolk: the Prize of TWENTY SOVEREIGNS, for his 6 years and 3 months-old pure North Devon in-calf Cow; bred by George Turner, of Barton, near Exeter.

JOHN BLOMFIELD, Jun., of Warham, near Wells, Norfolk: the Prize of TEN SOVEREIGNS, for his 10 years-old true North Devon in-milk and in-calf Cow; bred by James Quartly, of Molland, Devon.

THOMAS WHITE FOURACRE, of Durston, near Taunton, Somersetshire: the Prize of TWENTY SOVEREIGNS, for his 2 years and 7 months-old Devon in-calf Heifer; bred by himself.

JOHN BLOMFIELD, Jun., of Warham, near Wells, Norfolk: the Prize of TEN SOVEREIGNS, for his 2 years and 10 months-old true North Devon in calf Heifer; bred by himself.

ANTHONY HAMOND, of Westacre, near Swaffham, Norfolk: the Prize of TEN SOVEREIGNS, for his 1 year and 3 months-old Devon Yearling Heifer; bred by himself.

JOHN BLOMFIELD, Jun., of Warham, near Wells, Norfolk: the Prize of FIVE SOVEREIGNS, for his 1 year and 10 months-old true North Devon Yearling Heifer; bred by himself.

CATTLE: IV. *Any Breed* (not qualified to compete as Short-horns, Herefords, or Devons).

LIEUT.-COL. WILLIAM MASON, of Necton Hall, near Swaffham, Norfolk: the Prize of TWENTY SOVEREIGNS, for his 3 years and 7 months-old Blood-red Norfolk Polled Bull; bred by A. M. Whytock, of Necton, Norfolk.

LIEUT.-GEN. SIR EDWARD KERRISON, Bart., of Oakley Park, near Eye, Suffolk: the Prize of TEN SOVEREIGNS, for his 4 years and 5 months-old Suffolk Bull; bred by himself.

CAPTAIN WILLIAM INGE, of Thorpe Constantine, near Tamworth, Staffordshire: the Prize of TEN SOVEREIGNS, for his 1 year and 5 months-old pure Long-horned Bull; bred by R. Baker of Rollright, near Chipping Norton, Oxfordshire.

CAPTAIN WILLIAM INGE, of Thorpe Constantine, near Tamworth, Staffordshire: the Prize of TEN SOVEREIGNS, for his 7 years-old pure Long-horned in-calf Cow; bred by himself.

CAPTAIN WILLIAM INGE, of Thorpe Constantine, near Tamworth, Staffordshire: the Prize of FIVE SOVEREIGNS, for his 5 years and 8 months-old pure Long-horned in-calf Cow; bred by the Hon. M. W. B. Nugent, of Higham Grange, near Hinckley, Leicestershire.

John Villiers Shelley, of Maresfield Park, near Uckfield, Sussex: the Prize of Fifteen Sovereigns, for his 28 months-old Southdown Ram; bred by himself.

John Villiers Shelley, of Maresfield Park, near Uckfield, Sussex: the Prize of Twenty Sovereigns, for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

John Robert Overman, of Burnham Sutton, near Burnham Market, Norfolk: the Prize of Ten Sovereigns, for his pen of five 17 months-old Southdown Shearling Ewes; bred by himself.

Sheep: III. *Long-Wools.*

Charles Large, of Broadwell, near Lechlade, Gloucestershire: the Prize of Thirty Sovereigns, for his 16 months-old New Oxfordshire Long-woolled Shearling Ram; bred by himself.

William Garne, of Aldsworth, near Northleach, Gloucestershire: the Prize of Fifteen Sovereigns, for his 16 months-old Cotswold Long-woolled Shearling Ram; bred by himself.

Charles Large, of Broadwell, near Lechlade, Gloucestershire: the Prize of Thirty Sovereigns, for his 6 years-old New Oxfordshire Long-woolled Ram; bred by himself.

William Garne, of Aldsworth, near Northleach, Gloucestershire: the Prize of Fifteen Sovereigns, for his 52 months-old Cotswold Long-Woolled Ram; bred by himself.

Charles Large, of Broadwell, near Lechlade, Gloucestershire: the Prize of Twenty Sovereigns, for his pen of five 16 months-old New Oxfordshire Long-woolled Shearling Ewes; bred by himself.

Charles Large, of Broadwell, near Lechlade, Gloucestershire: the Prize of Ten Sovereigns, for his pen of five 16 months-old New Oxfordshire Long-woolled Shearling Ewes; bred by himself.

Pigs.

Ashley H. Wilson, of the Abbey, near Wigton, Cumberland: the Prize of Fifteen Sovereigns, for his 3 years-old Solway Boar, of a large breed; bred by himself.

Edwin Eddison, of Headingley Hill, Leeds, Yorkshire: the Prize of Five Sovereigns, for his 4 years and 2 months-old Boar of a large breed; bred by David Cooper, of Shadwell, near Leeds.

William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: the Prize of Fifteen Sovereigns, for his 11 months and 2 weeks-old improved Essex Boar, of a small breed; bred by himself.

Lieut.-Gen. Sir Edward Kerrison, Bart., of Oakley Park, near Eye, Suffolk: the Prize of Five Sovereigns, for his 1 year and 7 months-old Essex Boar, of a small breed; bred by himself.

Joseph Tuley, of Exleyhead, near Keighley, Yorkshire: the Prize of Ten Sovereigns, for his 2 years and 2 months-old Sow, of a large breed; bred by Thomas Sugden, of Keighley, Yorkshire.

Joseph Tuley, of Exleyhead, near Keighley, Yorkshire: the Prize of Ten Sovereigns, for his 11 months and 3 weeks-old Sow, of a small breed; bred by Mary Roe, of Bocking, near Bingley, Yorkshire.

Mark Stainsby, Jun., of No. 30, Lady Pitt Lane, Hunslet, near Leeds, Yorkshire: the Prize of Ten Sovereigns, for his pen of three 4 months and 6 days-old improved Cleveland Breeding Sow-pigs, of a large breed; bred by Thomas Stainsby, of Hunslet, Yorkshire.

William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: the Prize of Ten Sovereigns, for his pen of three 22 weeks-old improved Essex Breeding Sow-pigs, of a small breed; bred by E. G. Barnard, M.P., of Gosfield Hall, near Halstead, Essex.

Commendations.

*Lord Hastings, of Melton Constable, near East Dereham, Norfolk: for his 1 years and 2 months-old Short-Horned Bull; bred by himself.

Thomas [illegible] Warman, of Wootton Bassett, Wiltshire: for his 4 years and nearly 4 months-old Durham Short-Horned Bull; bred by Christopher Bevan, of Highway, near Calne, Wiltshire.

*The Marquis of Exeter, of Burghley House, near Stamford, Lincolnshire: for his 3 years and 7 months-old pure Short-Horned Bull; bred by himself.

*John Forrest, of Stretton, near Warrington, Lancashire: for his 3 years 2 months and 17 days-old Short-Horned Bull; bred by John O. G. Pollock, of Mountainstown, Navan, Ireland.

*The Marquis of Londonderry, of Wynyard Park, near Stockton-on-Tees, Durham: for his 5 years and 3 months-old Short-Horned Bull; bred by John Wood of Kibblesworth, near Durham.

*William Dunkley Manning, of Rothersthorpe, near Northampton: for his 4 years and 2 months-old Short-Horned Bull; bred by himself.

*John Hall, of Kiveton Park, near Sheffield, Yorkshire: for his 5 years-old Short-Horned Bull; bred by himself.

John Forrest, of Stretton, near Warrington, Lancashire: for his 5 years 2 months and 8 days-old Short-Horned in-Milk and in-Calf Cow; bred by John Parkinson, of Leyfields, near Newark, Nottinghamshire.

*Richard Booth, of Warlaby, near Northallerton, Yorkshire: for his 5 years and 2 months-old in-Milk and in-Calf Short-Horned Cow; bred by himself.

*William Fowle, of Market Lavington, near Devizes, Wiltshire: for his 4 years and 7 months-old pure Short-Horned in-Calf Cow; bred by Lieut.-Col. Dalgairns, of Inglision, near Glammis, N.B.

*William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: for his 5 years and 3 months-old Short-Horned in-Calf Cow; bred by E. G. Barnard, M.P., of Gosfield Hall, near Halstead, Essex.

The Marquis of Londonderry, of Wynyard Park, near Stockton-on-Tees, Durham: for his 3 years and 10 months-old Short-Horned in-Calf Cow; bred by John Robinson, of Leckby Palace, Yorkshire.

*William Tod, of Elphinstone Tower, near Tranent, N.B.: for his 4 years and 4 months-old Short-Horned in-Calf Cow; bred by himself.

*The Lord Feversham, of Duncombe Park, near Helmsley, Yorkshire: for his 2 years and 8 months-old pure Short-Horned in-Calf Heifer; bred by himself.

William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: for his 2 years and 3 months-old Short-Horned in-Calf Heifer; bred by E. G. Barnard, M.P., of Gosfield Hall, near Halstead, Essex.

John Kirkham, of Hagnaby, near Spilsby, Lincolnshire: for his 1 year 2 months 3 weeks and 6 days-old Short-Horned Yearling Heifer; bred by himself.

*William Smith, of West Rasen, near Market Rasen, Lincolnshire: for his 1 year 9 months and 19 days-old Short-Horned Yearling Heifer; bred by himself.

William Smith, of West Rasen, near Market Rasen, Lincolnshire; for his 1 year 6 months and 29 days-old Short-Horned Yearling Heifer; bred by himself.

Thomas Crisp, of Gedgrave, near Woodbridge, Suffolk: for his 1 year and 11 months-old Short-Horned Yearling Heifer; bred by himself.

Charles Towneley, of Towneley Hall, near Burnley, Lancashire: for his 1 year and 9 months-old pure Short-Horned Yearling Heifer; bred by Sir C. R. Tempest, Bart., of Broughton Hall, Yorkshire.

William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: for his 2 years and 4 months-old pure Hereford in-Calf Heifer; bred by himself.

*Edward Price, of the Courthouse, Pembridge, near Leominster, Herefordshire: for his 1 year and 5 months-old Hereford Yearling Heifer; bred by himself.

Lord Berwick, of Cronkhill, near Shrewsbury; for his 1 year and 9 months-old Hereford Yearling Heifer; bred by himself.

*The Earl of Leicester, of Holkham Hall, near Wells-next-the-Sea, Norfolk: for his 3 years and 11 months-old pure North Devon Bull; bred by George Turner of Barton, near Exeter.

Thomas White Fouracre, of Durston, near Taunton, Somersetshire: for his 5 years and 10 months-old Devon Bull; bred by himself.

Thomas Miller, of Castle Farm, near Sherborne, Dorsetshire: for his 3 years and 11 months-old Devon Bull; bred by Mr. Bouchier, of Wiveliscombe, Somersetshire.

Thomas White Fouracre, of Durston, near Taunton, Somersetshire: for his 3 years and 7 months-old Devon in-Milk and in-Calf Cow; bred by himself.

John Ayre Thomas, of Ditchett, Rose Ash, near South Molton, Devonshire; for his 5 years and 6 months-old pure North Devon in-Calf Cow; bred by himself.

*Samuel Farthing, of Nether Stowey, near Bridgwater, Somersetshire: for his 2 years and 3 months-old pure Devon in-Calf Heifer, bred by himself.

George Turner, of Barton, near Exeter: for his 2 years and 4 months-old pure North Devon in-Calf Heifer; bred by himself.

John Blomfield, Jun., of Warham, near Wells, Norfolk: for his 1 year and 11 months-old true North Devon Yearling Heifer; bred by himself.

Thomas Beards, of Stowe, near Buckingham: for his 9 years 6 months and 3 days-old Long-Horned in-Milk and in-Calf Cow; bred by the Duke of Buckingham, of Stowe, near Buckingham.

Lieut.-Gen. Sir Edward Kerrison, Bart., of Oakley Park, near Eye, Suffolk: for his 2 years and 11 months-old Suffolk in-Calf Heifer; bred by himself.

William Halford, of Broughton Astley, near Lutterworth, Leicestershire: for his 5 years-old Cart Agricultural Stallion; bred by John Garrett, of Knossington, Leicestershire.

John Ward, of East Mersea, near Colchester, Essex: for his 8 years-old Suffolk Agricultural Stallion; bred by Samuel Wrinch, of Great Holland, Essex.

Robert Fellowes, of Shotesham Park, near Norwich: for his 3 years-old Suffolk Agricultural Stallion; bred by himself.

*The Hon. Henry William Wilson, of Keythorpe Hall, near Tugby, Leicestershire: for his 4 years-old Suffolk Agricultural Stallion; bred by himself at Kirby Cave, Norfolk.

Thomas Catlin, of Butley, near Woodbridge, Suffolk: for his 3 years-old pure Suffolk Cart Agricultural Stallion; bred by himself.

Frederick Thomas Bryan, of Knossington, near Oakham, Rutlandshire: for his 2 years-old Cart Agricultural Stallion; bred by William Shuttlewood, of Oakham, Rutlandshire.

*William Fisher Hobbs, of Boxted Lodge, near Colchester, Essex: for his 2 years-old pure Suffolk Agricultural Stallion; bred by himself.

Thomas Beale Browne, of Salperton, near Andoversford, Gloucestershire: for his 4 years-old Suffolk Dray Stallion; bred by Mr. Swonder, in Hertfordshire.

George Gower, of Dilham, near Smallburgh, Norfolk: for his 4 years-old Norfolk Nag Roadster Stallion; bred by John Ward, of Blickling, near Aylsham, Norfolk.

*Cubit Wells, of Sedgeford, near Lynn Regis, Norfolk: for his 4 years-old Roadster Stallion; bred by Mr. Wood, of Merton, Norfolk.

*Thomas Richard Ellis, of Oxnead Hall, near Buxton, Norfolk: for his Agricultural Mare and Foal; the mare bred by Robert Goulder, of Haveton, Norfolk; the sire of the foal belonged to himself.

*Lieut.-Gen. Sir Edward Kerrison, Bart., of Oakley Park, near Eye, Suffolk: for his Agricultural Mare and Foal; the mare bred by himself; the sire of the foal belonged to N. G. Barthropp, of Cretingham Rookery, Suffolk.

Gibbs Howes Murrell, of Intwood, near Norwich: for his Agricultural Mare and Foal; the mare bred by John Smith, of Wramplingham, Norfolk; the sire of the foal belonged to George Gowing, of Trowse, near Norwich.

William Pike Salter, of Whinburgh, near East Dereham, Norfolk: for his Agricultural Mare and Foal; the mare bred by Stephen Hubbard, of Reymerstone, near East Dereham; the sire of the foal belonged to Joseph Cordy, of Shipdham, near East Dereham, Norfolk.

William Pike Salter, of Whinburgh, near East Dereham, Norfolk, for his Agricultural Mare and Foal; the mare bred by himself; the sire of the foal belonged to Joseph Cordy, of Shipdham, near East Dereham, Norfolk.

William Smith, of Easthorpe, near Bottesford, Leicestershire: for his Agricultural Mare and Foal; the mare bred by himself; the sire of the foal belonged to Thomas Bryan, of Knossington, Leicestershire.

N. G. Barthropp, of Cretingham Rookery, near Woodbridge, Suffolk: for his Agricultural Mare and Foal; the mare bred by Nathaniel Barthropp, of Cretingham Rookery, near Woodbridge, Suffolk; the sire of the foal belonged to himself.

John Sewell, of North Pickenham, near Swaffham, Norfolk: for his Agricultural Mare and Foal; the breeder of the mare not known; the sire of the foal belonged to Mr. Stratton, of Pentney, Norfolk.

John Josselyn, of Sproughton, near Ipswich, Suffolk: for his Agricultural Mare and Foal; the mare bred by himself; the sire of the foal belonged to Mr. Pallent, of Rendham, Suffolk.

Samuel Sewell, of Hethersett, near Wymondham, Norfolk: for his Agricultural Mare and Foal: the mare bred by himself; the sire of the foal belonged to Mr. Cunningham, of Kimberley, near Wymondham, Norfolk.

Henry Crosse, of Boyton Hall, near Stowmarket, Suffolk: for his Agricultural Mare and Foal; the breeder of the mare not known; the sire of the foal belonged to himself.

William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: for his Agricultural Mare and Foal; the mare bred by Mr. Catlin, of Butley Abbey, near Saxmundham, Suffolk; the sire of the foal belonged to himself.

Spencer Rudrum, of Norwich: for his Agricultural Mare and Foal; the breeder of the mare not known; the sire of the foal belonged to himself.

Lord St. John, of Melchbourne, near Higham Ferrers, Northamptonshire: for his Agricultural Mare and Foal; the mare bred by himself; the sire of the foal belonged to the Duke of Manchester.

Barnabus Bond, of Alburgh, near Harleston, Norfolk: for his Agricultural Mare and Foal; the mare bred by himself; the sire of the foal belonged to Benjamin Ellis, of Hempnall, Norfolk.

Thomas Catlin, of Butley, near Woodbridge, Suffolk: for his 2 years-old Agricultural Filly; bred by himself.

*Charles Frost, of Wherstead, near Ipswich, Suffolk: for his 2 years-old Agricultural Filly; bred by himself.

*Joseph Stubbins Burgess, of Holme Pierrepoint, near Nottingham: for his pen of five 16 months-old Leicester Shearling Ewes; bred by himself.

*Jonas Webb, of Babraham, near Cambridge: for his 16 months-old Southdown Shearling Ram; bred by himself.

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Jonas Webb, of Babraham, near Cambridge: for his 16 months-old Southdown Shearling Ram; bred by himself.

*The Duke of Richmond, of Goodwood, near Chichester, Sussex: for his pen of five 17 months-old Southdown Shearling Ewes; bred by himself.

*The Earl of Chichester, of Stanmer, near Lewes, Sussex: for his pen of five 16 months-old Southdown Shearling Ewes; bred by himself.

George Hewer, of Leygore, near Northleach, Gloucestershire: for his 16 months-old Cotswold Long-woolled Shearling Ram; bred by himself.

William Garne, of Aldsworth, near Northleach, Gloucestershire: for his 16 months-old Cotswold Long-woolled Ram; bred by himself.

George Hewer, of Leygore, near Northleach, Gloucestershire: for his 28 months-old Cotswold Long-woolled Ram; bred by himself.

*William Garne, of Aldsworth, near Northleach, Gloucestershire: for his 40 months-old Cotswold Long-woolled Ram; bred by himself.

*George Hewer, of Leygore, near Northleach, Gloucestershire: for his pen of five 16 months-old Cotswold Long-woolled Shearling Ewes; bred by himself.

Lord Berwick, of Cronkhill, near Shrewsbury: for his 1 year and 1 month-old Cronkhill Boar of a small breed; bred by himself.

Timothy Smith, of Hoyland Hall, near Barnsley, Yorkshire: for his 1 year and 1 month-old Boar of a small breed; bred by Edward Smith, of Bruntcliffe Lodge, near Leeds, Yorkshire.

*William Fisher Hobbs, of Boxtead Lodge, near Colchester, Essex: for his 1 year 10 months 2 weeks and 3 days-old improved Essex Boar of a small breed; bred by himself.

Robert Smith, jun., of Sharow, near Ripon, for his 11 months and 2 weeks-old improved Boar of a small breed; bred by himself.

•William Greenwood, of Rawfolds, near Leeds, Yorkshire: for his 1 year and 11 months-old Cleveland Sow of a large breed; bred by Robert Wilson, of Stockton-on-Tees, Durham.

John Armstrong Storey, of Happisburgh, near Stalham, Norfolk: for his 11 months-old improved Norfolk Sow of a small breed; bred by himself.

Henry Overman, of Weasenham St. Peter, near Rougham, Norfolk: for his 11 months-old Norfolk Sow of a small breed; bred by himself.

•John Gillett, of Tunstall, near Acle, Norfolk: for his 3 years and 2 weeks-old improved Norfolk Sow of a small breed; bred by himself.

•Timothy Smith, of Hoyland Hall, near Barnsley, Yorkshire: for his 5 years and 1 month-old Sow of a small breed; bred by the Rev. Charles George Smith, of Everton.

•William Fisher Hobbs, of Boxtead Lodge, near Colchester: for his 10 months-old improved Essex Sow of a small breed; bred by E. G. Barnard, M.P., of Gosfield Hall, near Halstead, Essex.

•The Earl of Radnor, of Coleshill, near Faringdon, Berkshire: for his pen of three 31 weeks-old Coleshill Breeding Sow Pigs of a small breed; bred by himself.

Timothy Smith, of Hoyland Hall, near Barnsley, Yorkshire: for his pen of three 29 weeks-old Breeding Sow Pigs of a small breed; bred by himself.

EXTRA STOCK COMMENDATIONS.

John Gamble, of Shouldham Thorpe, near Downham Market, Norfolk: for his 6 years and 4 months-old pure Short-horned In-Milk Cow; bred by himself.

•David Wright, sen., of Upworth, near Ixworth, Suffolk: for his 1 year and 2 months-old Suffolk Cart Colt; bred by himself.

•John Abel, of Norwich: for his 4 years-old Thorough-bred Horse; breeder unknown.

George J. Morgan, of Sycamore House, Bramford, near Ipswich, Suffolk: for his 3 years old entire Colt; bred by himself.

•J. R. W. Atkinson, of Elmwood House, near Leeds, Yorkshire: for his 1 year and 11 months-old Boar of a small black breed; bred by Robert Smith, of Givendale, near Ripon, Yorkshire.

•Joseph Tuley, of Exleyhead, near Keighley, Yorkshire: for his 4 years-old Sow with her litter; the Sow bred by Samuel Clarkson, of Leeds, Yorkshire.

IMPLEMENTS.

William Williams, of Bedford, and Lawrence Taylor, of Cotton End, near Bedford, for the Plough best adapted to heavy land — Five Sovereigns.

John Howard and Son, of Bedford, for the Plough best adapted to light land . . . . Five Sovereigns.

William Ball, of Rothwell, near Kettering, Northamptonshire, for the Plough best adapted for general purposes Five Sovereigns.

George Kilby, of Queniborough, near Leicester, for the best Paring Plough . . . . Five Sovereigns.

James Comins, of South Molton, Devonshire, for the best Subsoil Pulverizer . . . . . . Five Sovereigns.

Richard Hornsby, of Spittlegate, Grantham, for the best Drill for general purposes . . . . Fifteen Sovereigns.

Richard Garrett and Son, of Leiston Works, near Saxmundham, Suffolk, for the best Corn Drill . . Ten Sovereigns.

Richard Hornsby, of Spittlegate, Grantham, for the best Turnip Drill on the flat . . . . . Ten Sovereigns.

Richard Garrett and Son, of Leiston Works, near Saxmundham, Suffolk, for the best Turnip Drill on the ridge Ten Sovereigns.

Richard Garrett and Son, of Leiston Works, near Saxmundham, Suffolk, for the best Drop Drill for depositing seed and manure Ten Sovereigns.

William Crosskill, of the Iron Works, near Beverley, Yorkshire, for the best Manure Distributor . . Five Sovereigns.

Richard Garrett and Son, of Leiston Works, near Saxmundham, Suffolk, for the best portable Steam Engine applicable to Thrashing or other Agricultural purposes . . Fifty Sovereigns.

Clayton, Shuttleworth, and Co., of Lincoln, for the second best portable Steam Engine applicable to Thrashing or other Agricultural purposes . . . Twenty-five Sovereigns.

Richard Garrett and Son, of Leiston Works, near Saxmundham, Suffolk, for the best portable Thrashing Machine applicable to Horse or Steam Power . . Twenty-five Sovereigns.

Richard Hornsby, of Spittlegate, Grantham, Lincolnshire, for the best Corn-Dressing Machine . . . Ten Sovereigns.

Clayton, Shuttleworth, and Co., of Lincoln, for the best Grinding Mill for breaking agricultural produce into fine meal Ten Sovereigns.

Hurwood and Turner, of St. Peter's Foundry, Ipswich, Suffolk, for the best Linseed and Corn Crusher . Five Sovereigns.

John Cornes, of Barbridge, near Nantwich, Cheshire, for the best Chaff Cutter . . . . . . Ten Sovereigns.

The Executors of the late James Gardner, of Banbury, Oxfordshire, for the best Turnip Cutter . . . Five Sovereigns.

William Newzam Nicholson, of Newark-on-Trent, for the best Oil-Cake Breaker . . . . . Five Sovereigns.

William Crosskill, of the Iron-Works, near Beverley, Yorkshire, for the best One-Horse Cart . . . Ten Sovereigns.

William Crosskill, of the Iron-Works, near Beverley, Yorkshire, for the best Harvest Cart . . . . Ten Sovereigns.

William Crosskill, of the Iron-Works, near Beverley, Yorkshire, for the best Waggon . . . . Ten Sovereigns.

John Whitehead, of Preston, Lancashire, for the best Machine for making Draining Tiles or Pipes for Agricultural purposes Twenty Sovereigns.

Mapplebeck and Lowe, of Birmingham, for the best Set of Tools for general Draining . . . Three Sovereigns.

William Williams, of Bedford, and Lawrence Taylor, of Cotton End, near Bedford, for the best Heavy Harrow Five Sovereigns.

William Williams, of Bedford, and Lawrence Taylor, of Cotton End, near Bedford, for the best Light Harrow Five Sovereigns.

Stratton, Hughes, and Co., of Bristol, for the best Norwegian Harrow . . . . Five Sovereigns.

Ransomes and May, of Ipswich, Suffolk, for the best Scarifier Ten Sovereigns.

Smith and Co., of Stamford, Lincolnshire, for the best Cultivator or Grubber . . . . Ten Sovereigns.

Richard Garrett and Son, of Leiston Works, near Saxmundham, Suffolk, for the best Horse Hoe on the flat . Ten Sovereigns.

William Busby, of Newton-le-Willows, near Bedale, Yorkshire, for the best Hoe on the ridge . . . . Five Sovereigns.

William Williams, of Bedford, and Lawrence Taylor, of Cotton End, near Bedford, for the best Horse Rake Five Sovereigns.

Samuel Newington, M.D., of Knowle Park, Frant, near Tunbridge Wells, Kent, for the best Hand Dibbler . Three Sovereigns.

John Holmes, of Norwich, for the best Barrow Hand Drill to work with cups . . . . . . Three Sovereigns.

Robert and John Reeves, of Bratton, near Westbury, Wiltshire, for the best Liquid Manure Distributor . Five Sovereigns.

Smith and Co., of Stamford, Lincolnshire, for the best Haymaking Machine . . . . Five Sovereigns.

Barrett, Exall, and Andrewes, of Katesgrove Iron-Works, near Reading, Berkshire, for the best Gorse Bruiser Five Sovereigns.

William Prockter Stanley, of Peterborough, Northamptonshire, for the best and most economical Steaming Apparatus for general purposes . . . . Five Sovereigns.

Ransomes and May, of Ipswich, Suffolk, for their patent Universal Corn and Seed Dropping Machine . . Silver Medal.

William Busby, of Newton-le-Willows, near Bedale, Yorkshire, for his registered Ribbing and Drilling Machine Silver Medal.

Richard Hornsby, of Spittlegate, near Grantham, Lincolnshire, for his invention of Depositing the Manure on the Ridge before the Roller, and combining the two principles of the Ridge and the Flat in the same Implement . . . Silver Medal.

Richard Downs, of Ryhall, near Stamford, Lincolnshire, for his Plough for general purposes . . . Silver Medal.

Ransomes and May, of Ipswich, Suffolk, for their patent Trussed Beam Iron Universal Plough, marked Y U L Silver Medal.

James Hunter, of Kelso, Roxburghshire, N. B., for his Cart Saddle Silver Medal.

Robert Wedlake, and Ann Thompson, of Union Foundry, Hornchurch, near Romford, Essex, for their Patent Irrigator Silver Medal.

Ransomes and May, of Ipswich, Suffolk, for their Digging Fork Silver Medal.

John Whitehead, of Preston, Lancashire, for his Registered Churn Silver Medal.

William Crosskill, of the Iron-Works, near Beverley, Yorkshire, for his Portable Farm Railway, Portable Railway Turntable, &c., and Portable Farm Railway Waggon . Silver Medal.

Charles Burrell, of Thetford, Norfolk, for his Circular-saw Bench, or Machine for making Hurdles or Gates . Silver Medal.

Thomas Scragg, of Calveley, near Tarporley, Cheshire, for Improvements in Cutting Wires and Die Plates . Silver Medal.

Charles Edwards Amos (of the Firm of Easton and Amos), Consulting-Engineer to the Society, for his improvements in apparatus for the Dynamometrical testing of agricultural implements and machinery . . . . . Gold Medal.

COMMENDATIONS.

*Thomas Scragg, of Calveley, near Tarporley, Cheshire: for his single-action Tile, Pipe, and Brick-making machine.

Hurwood and Turner, of St. Peter's Foundry, Ipswich, Suffolk, for their Portable Thrashing Machine.

[The Commendations are arranged in the order of the numbers of the Certificates to which they refer. The mark (*) signifies "highly commended;" the omission of it, "commended;" by the Judges.]

Royal Agricultural Society of England.

GENERAL MEETING.

12, Hanover Square, Wednesday, May 22, 1850.

REPORT OF THE COUNCIL.

The Council have the satisfaction of reporting to the members at their present half-yearly meeting the most favourable condition of the Society at the completion of the twelfth year from its foundation. Although in point of numbers its census is diminished by 127 members since the last general meeting, such diminution is in a great measure more apparent than real; for the average number of members periodically lost to the Society by death being deducted, the remaining names removed from the list will be found to be those of parties who had joined the Society at its country meetings for the local and temporary purposes only of the occasion. On the other hand, members who feel a deeper and more general interest in the welfare of the Society and the promotion of its national objects, are constantly elected into its body, and are gradually increasing its list of efficient members. The Society at the present time comprises 5261 members, namely—

90 Life Governors,
169 Annual Governors,
627 Life Members,
4356 Annual Members, and
19 Honorary Members.

The funds of the Society are in a highly satisfactory state; every claim against it has been constantly discharged as it has become due; an ample cash-balance lies available for current purposes in the hands of the bankers; and the invested capital has at length approximated to the gross amount of those sums which have been received from time to time, since the commence-

ment of the Society, as compositions for life. The arrears of subscription, so long the source of trouble to the Finance Committee, and of irregularity to the income of the Society and its means of usefulness, have at length, by the persevering attention of that Committee, been brought under salutary control and placed in train for final settlement. The names of defaulters, whose tardy fulfilment of their obligations to a Society into which they had voluntarily entered, and whose unwilling compliance with the chartered regulations of the general body have thus occasioned so much inconvenience to the Society and injury to its available income, have been gradually removed from the list of members, and replaced by the names of willing contributors to its funds, who cheerfully acquiesce in a recognition of the validity of general laws, enacted, under the charter of the Society, for indiscriminate application to all its members, and for carrying out by united efforts the great and useful objects of their incorporation. The Council, in dealing with this question of arrears, have accordingly felt it their bounden duty to the body at large, acting as their representatives and the appointed guardians of their common interest, to take the most decisive measures for bringing the settlement of this long-contested question to a final issue, by an appeal to the county courts of the kingdom. The administration of the Society being situate in London, and various obligations having been incurred within the jurisdiction of the metropolitan courts, the Council have commenced their actions by summoning to those courts such of their members in and about London as are more than two years in arrear of their subscription, and who are known, or are found on inquiry, to be in circumstances to justify, in their cases, the full enforcement of the claims in question. The summonses having been issued, the parties, on receiving them, have, with a single exception, declined offering any further opposition to the legal claim thus made upon them on the part of the Society, and have paid into court the whole amount of arrears, as well as the costs incurred. In the single case referred to, the summons was not answered by the defendant's either discharging the claim or

making his appearance, and the action accordingly took its course; when his Honour the Judge of the Westminster County Court, in which the case came on, having heard the grounds on which the action was brought, as well as the evidence adduced of due election and membership, and having ascertained the powers of the Society conferred upon it by its charter, at once decided on the validity of the Society's claim, and made a formal order of court, that the amount of arrears claimed, with the accumulated costs incurred, should be paid by the defendant on or before that day week. When the Council shall have thus cleared off the London list of arrears, they will feel it to be equally their duty to proceed in a similar legal manner to summon parties resident in the different counties of the kingdom whom they shall ascertain to be in a condition fully to meet their liabilities, and who by the time of such issuing of summons shall have failed to discharge their just obligations to the Society. The Council, however, having now established the principle on which they have sought to recover these arrears of subscription, and being thus fortified by a judical decision which leaves no doubt of the validity of the claim of the Society against all its members, trust that the remaining defaulters will no longer evade their obligations, and impose upon the Council the invidious task of enforcing the payment of these arrears in a court of law—a final appeal as painful for the Council to make, as it must be inconvenient and derogatory to the parties in arrear to become subject to. When the arrear list shall have thus been disposed of, the income of the Society will lose its anomalous character, and correspond in actual amount to the payments due from the willing contributors, of which the Society will then consist; and the funds being thus established on a regular basis, the estimated income and expenditure of the Society may at all times be satisfactorily adjnsted.

The Council have to report the favourable progress of the preparations for the country meeting of the Society, to be held this year in the city of Exeter, in July, in the week commencing on Monday, the 15th of that month, of which the Thursday will,

as usual, be the principal day of the show. In order, however, to meet the wishes of the Members and the public, heretofore so often expressed on this subject, that a longer period should be allowed for the due inspection of the live stock by all parties attending the meeting than the single day hitherto devoted to that object, the Council have decided this year to try, as an experiment, the extension of that period from one day to a day and a half—namely, on the Thursday, as formerly, and on the Friday from six o'clock in the morning till noon, when the stock will be at liberty to leave the yard; the result of which experiment will be a guide to the Council in their arrangement for future years. The entries for implements and stock for the Exeter Meeting promise to be as numerous as for the previous country meetings of the Society; and the various railway companies have received the application of the Council for concessions in favour of the Society's exhibitors, in a spirit no less courteous than in former years, and there is every probability of an extension, on their part, of privileges no less liberal than heretofore, thus aiding by their powerful co-operation the national objects of the Society. The Council have accepted from Mr. Slaney, M.P., a renewal of his prizes for ploughs to cut out to a certain extent, and to fill in, drains; and from the South Devon Association a schedule of prizes for their local breed of stock, known as the South Hams Cattle: all of which prizes will be open to general competition, under the general regulations of the Society. The Council have also accepted the kind offers of Sir Thomas Dyke Acland, Bart., M.P., and Mr. Turner, of Barton, to submit to the Members, during the period of the Exeter Meeting, the construction and operation of their catch and water meadows, and to take measures for explaining on the spot, to all such visitors as will favour them with their company on the occasion, the theory and practice of irrigation in Devonshire. Mr. Hamond, of Westacre Hall, in Norfolk, has accepted the new appointment of steward-elect of implements at the Exeter Meeting, agreeably with the arrangement adopted for the first time this year, by which an opportunity will be afforded to the junior steward of implements

to qualify himself for the duties and details of that department; and Mr. Jonas, of Ickleton, in Cambridgeshire, has accepted the appointment of a steward of cattle at the country meetings of the Society, in the place of Mr. Kinder, who, after a long period of valuable services to the Society, retires this year by rotation from that office. The Council have again resorted to the same mode of appointing the judges for implements and stock as that of last year, namely, by requesting the members at large of the Society to favour them, at or before the present General Meeting, with the names of parties proposed by them as judges, and on whose behalf each proposer shall be ready to certify, on his personal knowledge, that they are in every respect qualified and willing to act as Judges in the particular classes for which they may be respectively recommended, and that they are unconnected with any exhibitor of stock or maker of implements, and have no direct personal interest in the stock exhibited, as breeders of any of the animals on which they may be called upon to adjudicate; and by referring these nominations to Special Committees, who will select and recommend to the Council the most fit persons, in their opinion, to fill respectively the office of Judge in the particular departments and classes of the Show. The Council, however, feeling, as they do deeply, how much the character of the Society, and the value of its prizes, depend on the talent, experience, and integrity of the Judges by whom the awards are made, and from whose decision there is no appeal, are fully sensible of the imperfection attendant on all the modes hitherto adopted for their nomination, selection, and appointment; and they are accordingly most anxious to receive and adopt any means that may be suggested to them, by which every just cause of suspicion and complaint, on the part of the exhibitors, may be obviated for the future. The position of the Western District, and the strong desire to profit by the means of agricultural improvement with which the presence of the Society has hitherto been accompanied; the direct communication by railway, from every part of the kingdom, to its different chief towns, and by sea to convenient ports on its northern and southern coasts; the varied

agricultural character of the south-western counties, of which that district is comprised; and the peculiar attractions offered to general visitors by the county of Devon alone, in which the Meeting will be held; are circumstances that will no doubt conspire, with the especial and more immediate objects of the occasion, in drawing together, in the city of Exeter, a very large and interesting meeting. The parties composing this numerous assemblage, by their personal communication and interchange of sentiment on topics of practical agriculture, will be enabled to promote among themselves a spirit of enlightened inquiry, by mutual comparison of local systems and their results; and at the close of the Meeting will in all probability carry back to their different neighbouring or distant residences throughout the country, such an improved acquaintance with the best mode of carrying into operation the most useful system of economy, both of the time and the means at their disposal, in every department of husbandry, as will lead to the adoption of modes of management by which the most effective results may, in every case, be obtained at the least expenditure of time and money: a mutual conference on topics of deep practical interest to the agricultural community, which it has been one of the great objects of the Society to recommend and promote, through the medium of its Country meetings.

The Council have accepted the invitation of the Royal Commission for the Exhibition of the Works of Industry of all Nations in 1851, to hold a Show of Cattle in Hyde Park in that year; but finding that the Royal Commission have included in the arrangements for their own Exhibition a department for agricultural implements, the Council, with a view of not interfering with this department of the Royal Exhibition, have resolved to omit the implement portion of the Society's Show in 1851, and to confine their exertions entirely to their Show of Cattle, as invited by the Royal Commission, and to take every means to render that Show interesting as an exhibition of Breeding Stock. In order to meet this new arrangement for the year 1851, the Council have re-adjusted accordingly their districts for the

Country Meetings of the ensuing four years, and have agreed to the following rotation:—

1851, *Middlesex District*, consisting of the county of Middlesex.
1852, *South-Eastern District*, comprising the counties of Kent, Surrey, and Sussex.
1853, *South-Wales District*, comprising the whole of South Wales, with the addition of the counties of Gloucester, Hereford, Monmouth, and Worcester.
1854, *East-Midland District*, comprising the counties of Leicester, Lincoln, Nottingham, and Rutland.

The Council trust that, as so large a portion of the Country Members of the Society, from every part of the kingdom, will probably visit London next year, the circumstance of the Society's Show of Cattle being held in Hyde Park will meet the wishes of a great majority of its body, and promote the general objects of the whole; while the postponement of the Society's accustomed Country Show for one year, in the pre-arranged rotation of districts, will prevent any failure that might probably occur in holding it at a time when another Exhibition will be drawing public attention, in an especial manner, to the Metropolis.

The Council have received from the Chemical Committee the Annual Report of Professor Way, the Consulting Chemist to the Society, on the satisfactory progress of the chemical investigations in his laboratory, of which the results will be published in the Society's Journal; and on the great increase, within the last quarter, of chemical analyses required for agricultural purposes by Members of the Society. The Council have adopted, on the recommendation of that Committee, the following subjects for investigation during the ensuing twelve months:—

1. The continuation of the investigation into the absorptive properties of soils, including clays.
2. The nutritive properties of the grasses.
3. The agricultural properties of the chalks and marls.
4. The chemical properties of water, with a view to its effects on irrigation, and on the health of animals.

The Members have already been favoured by Professor Way with three very interesting lectures during the present year: the first, on Guano, and on that extensive adulteration at present

6. The suitableness or otherwise of the farm buildings to improved husbandry.
7. The extent of under-draining effected in the county.
8. The improvements made since the Report of the Rev. Joseph Plymley in 1803.
9. The improvements still required in the county generally.

III. Diseases of Farm Horses.

Twenty Sovereigns will be given for the best Report on Diseases arising from the Mismanagement of Farm Horses.

1. Insufficient or improper food.
2. Overwork.
3. Insufficient shelter.
4. Neglect of incipient disease.
5. Want of medical skill in professional attendants.

IV. Diseases after Parturition.

Twenty Sovereigns will be given for the best Report on the Diseases after Parturition in Cows and Sheep, with the Remedies.

V. Production of Butter.

Ten Sovereigns will be given for the best Essay on the Production of Butter.

VI. Agricultural Chemistry.

Twenty Sovereigns will be given for the best Essay on any subject in Agricultural Chemistry.

VII. Agricultural Geology.

Fifty Sovereigns will be given for the best Report on the Agricultural Geology of England and Wales.

1. General view of strata.
2. General view of soils as connected or disconnected with the strata on which they rest, and the origin of the soil where they agree and where they differ.
3. Manures adapted to different soils.
4. Aptitude of different subsoils for different kinds of drainage.
5. Crops adapted to different soils.

VIII. Steam and other Motive Power.

Thirty Sovereigns will be given for the best Essay on the relative advantages of Steam and other Motive Power applicable to Agricultural purposes.

1. The best mode of applying horse-power.
2. The best mode of applying water-power.
3. The best mode of applying fixed steam-power.
4. The best mode of applying moveable steam-power.
5. Purposes to which power is applicable, as thrashing, chaff-cutting, &c.

These Essays must be sent to the Secretary, at 12, Hanover Square, London, on or before March 1, 1851, with the exception of those competing for Prize No. VIII., which need not be sent in until on or before March 1, 1852.

*** Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, and the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.*

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of such Essays, not obtaining the Prize, as he may think likely to be useful for the Society's objects, with a view of consulting the writer confidentially as to his willingness to place such paper at the disposal of the Journal Committee.

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* Competitors are requested to write their motto on the paper on which their names are written, as well as on the envelope.

6. The copyright of all Essays gaining prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

General Meetings in 1850-51.

The General December Meeting, in London, on Saturday, the 14th of December.

The General May Meeting, in London, on Thursday, May 22, 1851.

The Annual Country Meeting, at Hampton Court, in 1851.

Annual Subscriptions.

Subscriptions may be paid to the Secretary, in the most direct and satisfactory manner, either at the Office of the Society, No. 12, Hanover-Square, London, between the hours of ten and four, or by means of Post-Office orders, to be obtained on application at any of the principal Post-Offices throughout the kingdom, and made payable to him at the General Post-Office, London; but any cheque on a Bank, or other house of business in London, will be equally available, if made payable on demand. The subscriptions are due in advance for each year on the 1st of January, and are in arrear if unpaid by the 1st of June ensuing. No Member is entitled to the Journal, or to any other privilege of the Society, whose subscription is in arrear.

ELECTION, &c., OF MEMBERS.

Nomination.—Every candidate for admission into the Society must be proposed by a Member; the proposer to specify in writing the name, rank, usual place of residence, and post-town, of the candidate, either at a Council, or by letter to the Secretary. Every such proposal shall be read at the Council at which such proposal is made; or, in the case of the Candidate being proposed by a letter to the Secretary, at the first meeting of the Council next after such letter shall have been received.

Election.—At the next Meeting of the Council the election shall take place, when the decision of the Council shall be taken by a show of hands; the majority of the Members present to elect or reject. The Secretary shall inform Members of their election by a letter, in such form as the Council may from time to time direct.

Payments.—1. Annual.—The subscription of a Governor is 5*l.* and that of a Member 1*l.*, due in advance on the 1st of January of each year, and becoming in arrear if unpaid by the 1st of June. Members elected in November or December may date the commencement of their liabilities and privileges with the Society from the 1st of January in the ensuing year. 2. For Life.—Governors may compound for subscription during future life by paying at once the sum of 50*l.*, and Members by paying 10*l.* No Governor or Member in arrear of subscription can be allowed to enter into composition for life until such arrears have been paid.

Privileges.—The Journals of the Society for the year during which their subscription has been paid, transmitted by post, free of charge, to their address; analyses performed at a reduced charge by the consulting chemist; the liberty of attending all weekly Meetings of the Council and Lectures delivered before the Members in London, and of consulting the books in the library; leave to report the outbreak of disease amongst live stock, and to request the personal attendance of the Society's Veterinary Inspector; free entry of stock, and priority of claim for dinner and lecture tickets at the Country Meetings of the Society. No Member in arrear of his subscription is entitled to any of the privileges of the Society.

Liabilities.—All Members belong to the Society, and are bound to pay their annual subscriptions, until they shall withdraw from it by a notice in writing to the Secretary.

Resignation.—Members can only withdraw their names legally from the Society by a written notice to the Secretary, and the payment of all subscriptions due from them at the date of such notice.

Expulsion.—Members may be dismissed from the Society in the following manner:—Any ten Members of the Society may send, in writing, signed by their names, to the Council, a request that any Member of the Society shall be dismissed from the Society. Such request shall be placed in a conspicuous part of the Council-room, and a copy thereof transmitted by the post to the Member proposed to be so dismissed, signed by the Secretary. At the monthly Meeting of the Council which shall take place next after one month shall have elapsed after such request shall have been placed in the Council-room, the Council shall take the matter thereof into their consideration; but the Council shall not so take it into consideration unless twelve Members of the Council at the least shall be present. If this number is not present, the consideration of the request shall be adjourned to the next monthly Meeting of the Council, and so on till a monthly Meeting shall take place at which twelve Members are present. If the Council so constituted shall unanimously agree to the dismissal of such Member, he shall be no longer a Member of the Society; but if they do not unanimously agree to his dismissal, their decision shal be considered to have been made in his favour: Provided always, that his dismissal shall not relieve him from the payment of any debt previously due by him to the Society; and that, if a Life-Governor or Life-Member, he shall not have any claim to any portion of the commutation he has paid.

Consulting-Chemist.

The Council have fixed the following rates of Charge for Analyses to be made by the Consulting-Chemist for Members of the Society; who, to avoid all unnecessary correspondence, are particularly requested, in applying to him for analyses, to mention the kind of analysis they require, and to quote its number as specified in the subjoined schedule. The charge for analysis, together with the carriage of specimens, must be paid to him by the members at the time of application.

No. 1. An opinion as to the genuineness of a manure in the market, 7*s.* 6*d.* By this is meant such an opinion as could be formed by a scientific person, by inspection, with a few simple confirmatory experiments.—[It will protect from fraud, but is not calculated to assist in the choice of the best specimens, where all are genuine: it will inform the applicant whether a specimen of guano or oil-cake, for instance, be adulterated or not; but will not touch the question of its relative value as a pure specimen. Such an opinion will only apply to ordinary market articles, as guano, oil-cake, superphosphate of lime, sulphate of ammonia, gypsum, common salt, &c.] No. 2. Guano. A determination of nitrogen (ammonia) and of the earthy phosphates, &c., 1*l.* No. 3. Limestone. The proportion of lime, 7*s.* 6*d.*; the proportion of magnesia, 10*s.*; the proportion of lime and magnesia, 15*s.* This analysis is sufficient for many purposes; but in most limestones the phosphate and sulphate of lime, and magnesia, are present, though in small proportions; and inasmuch as it is impossible to say how much of the effect may be due to other minute ingredients, it is recommended that their quantity should always be determined. No. 4. Limestone, or marls, including carbonate, phosphate, and sulphate of lime, and magnesia, with sand and clay, 1*l.* No. 5. Partial analysis of a soil, including sand, clay, organic matter, and carbonate of lime, 1*l.* No. 6. Complete analysis of a soil, 3*l.* No. 7. Letter asking advice, one topic, 7*s.* 6*d.* On more than one topic, 10*s.* No. 8. Oil-cake, or dung, or any animal products, nitrogen, and phosphoric acid, 1*l.* Oil-cake, including nitrogen, oil, and phosphoric acid, 1*l.* 10*s.* No. 9. A determination of the quantity of carbonate and sulphate of lime in any specimen of water, 1*l.*

The address of Professor Way, the Consulting-Chemist to the Society, is No. 23, Holles Street, Cavendish Square, London.

*** Assistants.—As competent assistants will from time to time be required to carry on the increased operations in Professor Way's laboratory, he has made arrangements to receive a few pupils who may wish to qualify themselves in the practice of Agricultural Analyses.

Royal Agricultural Society of England.

1850—1851.

President.

THE DUKE OF RICHMOND.

Trustees.

Acland, Sir Thomas Dyke, Bart., M.P.
Braybrooke, Lord
Clive, Hon. Robert Henry, M.P.
Graham, Rt. Hon. Sir Jas., Bart., M.P.
Lawley, Sir Francis, Bart.
Neeld, Joseph, M.P.
Portman, Lord
Pusey, Philip, M.P.
Richmond, Duke of
Rutland, Duke of
Spencer, Earl
Sutherland, Duke of

Vice-Presidents.

Barker, Thomas Raymond
Chichester, Earl of
Downshire, Marquis of
Ducie, Earl of
Egmont, Earl of
Exeter, Marquis of
Fitzwilliam, Earl
Gooch, Sir Thos. Sherlock, Bart.
Hardwicke, Earl of
Hill, Viscount
Wellington, Duke of
Yarborough, Earl of

Members of Council.

Ashburton, Lord
Austen, Colonel
Barnett, Charles
Beasley, John
Bennett, Samuel
Blanshard, Henry
Bramston, Thomas William, M.P.
Brandreth, Humphrey
Burke, John French
Camoys, Lord
Cavendish, William George, M.P.
Challoner, Colonel
Childers, John Walbanke, M.P.
Denison, John Evelyn, M.P.
Druce, Samuel
Foley, John H. Hodgetts, M.P.
Garrett, Richard
Gibbs, B. T. Brandreth
Grantham, Stephen
Hammond, Anthony
Hobbs, William Fisher
Hudson, John
Johnstone, Sir John V. B., Bart., M.P.
Jonas, Samuel
Kinder, John
Lawes, John Bennet
Lemon, Sir Charles, Bart., M.P.
Miles, William, M.P.
Milward, Richard
Pelham, Hon. Dudley, M.P.
Price, Sir Robert, Bart., M.P.
Ridley, Sir Matthew White, Bart.
Sewell, Professor
Shaw, William
Shaw, William, junior
Shelley, John Villiers
Sheridan, Richard Brinsley, M.P.
Sillifant, John
Simpson, William
Slaney, Robert Aglionby, M.P.
Smith, Robert
Southampton, Lord
Stansfield, W. R. Crompton, M.P.
Stradbroke, Earl of
Thompson, Henry Stephen
Turner, Charles Hampden
Turner, George
Webb, Jonas
Wilson, Henry
Wilson, Hon. Henry William.

Secretary.

JAMES HUDSON, 12, *Hanover Square, London.*

Consulting-Chemist—JOHN THOMAS WAY, 23, Holles Street, Cavendish Square.
Veterinary-Inspector—JAMES BEART SIMONDS, Royal Veterinary College.
Consulting-Engineer—JAMES EASTON, of C. E. AMOS, The Grove, Southwark.
Seedsmen—THOMAS GIBBS and Co., Corner of Halfmoon Street, Piccadilly.
Publisher—JOHN MURRAY, 50, Albemarle Street.
Bankers—R., A. M., C., A. R., G., and H. DRUMMOND, Charing Cross.

General Meetings in 1851.

The General May Meeting, in London, on Thursday, May 22, 1851.

The Annual Country Meeting, in 1851.

The General December Meeting, in London, on the Saturday in the week of the Meeting of the Smithfield Club in December, 1851.

Annual Subscriptions.

Subscriptions may be paid to the Secretary, in the most direct and satisfactory manner, either at the Office of the Society, No. 12, Hanover-Square, London, between the hours of ten and four, or by means of Post-Office orders, to be obtained on application at any of the principal Post-Offices throughout the kingdom, and made payable to him at the General Post-Office, London; but any cheque on a Banker's, or other house of business in London, will be equally available, if made payable on demand. The subscriptions are due in advance for each year on the 1st of January, and are in arrear if unpaid by the 1st of June ensuing. No Member is entitled to the Journal, or to any other privilege of the Society, whose subscription is in arrear.

Essays and Reports.

All Essays and Reports competing for the Prizes of the Society in this department for next year, are to be sent to the Secretary, 12, Hanover Square, London, on or before the 1st of March, 1851, with the exception of those competing for the Prize for the Essay on Steam and other Motive Power, which need not be sent in until on or before March 1, 1852. The conditions of competition were printed at length in the Appendix to the last Part of the Journal (pages xxxix.—xli.), and may be had separately on application, either personally or by post, to the Secretary.

Royal Agricultural Society of England.

GENERAL MEETING.

12, Hanover Square, Saturday, Dec. 14, 1850.

REPORT OF THE COUNCIL.

The Council have again the satisfaction of reporting favourably of the progress made by the Society in the attainment of its practical and useful objects. The number of its Members at the present time differs by only 18 from its amount at the date of the last General Meeting, 174 names having been removed by death or otherwise from the list, while 156 new Members have, during the same period, been elected into the Society, which now consists of—

90 Life Governors,
167 Annual Governors,
648 Life Members,
4315 Annual Members, and
19 Honorary Members;

making a total of 5,239.

Among the Governors lost to the Society by death, the Council have to record a name illustrious from its connection with the Royal Family of England, and endeared to the nation as borne by a Prince distinguished by so many virtues as his Royal Highness the Duke of Cambridge; a name, too, familiar and friendly in an especial manner to the Royal Agricultural Society of England, on account of the deep interest taken by his Royal Highness in the formation and welfare of the Society, and his participation in the promotion of its Country Meetings.

The Council have to report favourably on the state of the

Finances of the Society; and to submit to the members the half-yearly balance-sheet of the general account, and the special balance-sheet of the country meeting at Exeter, along with the quarterly statements of income and expenditure, assets and liabilities, funded property, and current cash account, laid before the Council by the Finance Committee and Auditors.

The Journal of the Society, transmitted postage free to the members in August last, will have borne to them in its own pages the best evidence of its intrinsic value. The succeeding part, now on the eve of publication, will no less, the Council believe, sustain the high character of its predecessor, and still further evince to the Society the high privilege its members enjoy in being favoured with so large an amount of the devoted attention of Mr. Pusey, who, in his capacity of chairman of the Journal Committee, effects that selection, arrangement, and elaboration of matter for its pages, which results in so valuable a collection of data for immediate application in given cases, and for the further advancement of agricultural knowledge. "Books," it is true, as Mr. Pusey himself remarks, "will not teach farming; but," he adds, "if they describe the practices of the best farmers, they will make men think, and show where to learn it. If our farmers will inquire what is done by the foremost of them, they will themselves write such a book of agricultural improvement, as never was written elsewhere, in legible characters, with good straight furrows, on the broad page of England." The Council trust that the best practice, whether obtained from the pages of the Journal or from personal inspection of the best farming, will be thus transferred to the hitherto neglected lands of the kingdom, and lead to results alike satisfactory to all parties connected with them. The Council are gratified to find that, of all the Journals sent to the members by post, amounting in number to nearly 30,000 copies, only one case has been made known to them in which a Journal has not eventually reached its destination: and they regard this fact as not only important to the Society, but as reflecting the highest credit on the postal establishment of the country.

The Council have only to refer to the Country Meeting of the Society, held at the city of Exeter in July last, with the liveliest satisfaction, and to pronounce it as complete in all its details as the Council could desire; the excellence of that meeting having been witnessed by all who had the pleasure of being present at it, and made known by public report to all others interested in its success who were, from various causes, unavoidably absent. Those only, however, that were present on the occasion could be impressed with an adequate idea of the demonstrations of hearty welcome given to the Society by the inhabitants of that "ancient and loyal city;" an expression of respect only equalled by their disinterestedness and genuine hospitality. The mayor and corporation, and the local committee, anticipated by their prompt and judicious measures every wish of the Society during the preparations for the meeting, and the period of holding it. Sir Thomas Acland at Killerton, and Mr. Turner at Barton, each gave a kind and friendly reception to the Members, and submitted to their inspection their respective Water and Catch Meadows, which created a lively interest in all who inspected them. The principal Railway Companies, with their usual liberality, conveyed the live stock free along their respective lines to and from the Show, and the implements at half the ordinary rates. The Members were indebted to Professor Simonds for a valuable Lecture on the Diseases of the Liver in Domesticated Animals. Messrs. Tuxford of Boston, and Messrs. Barrett and Co. of Reading, kindly placed at the disposal of the Stewards and Judges their respective steam-engines for driving the machinery under trial in the show-yard. The Society conveyed to all these respective parties, at the time, their grateful acknowledgments for the valuable services they had rendered to the Society by their cordial co-operation. The Exeter Meeting was also distinguished by a still further improvement introduced into the dynamometrical testing of the agricultural machinery, by which new results, of great importance in guiding the Judges in their decisions, were obtained; and the rival exhibitors of implements enabled themselves to judge of the actual power and working of their machines

by simple inspection of the mechanical registration of results. Colonel Challoner, the Senior Steward of Implements on that occasion, has made to the Society his report of the exhibition and trial of implements at the Exeter Meeting, including a description of the testing apparatus employed, and diagrams illustrating the momentary variation of the actual power either possessed by the steam-engines as prime movers, or required to work the various agricultural machines submitted to the test of trial. If anything were further required to prove the excellence of the Exeter Meeting, it would be the occurrence, for the first time in the records of the Society, of the receipts being equal to or exceeding the payments on account of a Country Meeting, independently of the Prizes awarded on the occasion; the Exeter balance-sheet now laid before the Members showing a balance of 96*l.* 2*s.* 9*d.* in favour of the Society.

The Council, agreeably with the bye-laws of the Society, prepared, on Thursday last, a list of the prizes for breeding-stock, to be offered for competition next year. This list having been printed, copies of it are now laid on the table for the information of the Members.

The Council have appointed a Special Committee to take into consideration the whole question of nominating, selecting, and appointing the judges for the country meetings, with a request that they will favour the Council with their report on the subject in February next. They have also appointed a certain number of their members to meet the Governors of the Royal Veterinary College, for the purpose of conferring with them on the best mode of carrying out the common object of the two bodies, namely, the application of veterinary science to the diseases of cattle, sheep, and pigs; with a request that they also will report the result of their conference at the same date. Professor Simonds, the Veterinary Inspector of the Society, has reported to the Council the result of his inquiry into the occurrence of several important cases of disease amongst the stock of Members in different parts of the country. These reports, when fully completed by further results of direct experiments in the feeding and treat-

ment of the animals, will be placed in the hands of the Journal Committee.

Professor Way, the Consulting Chemist to the Society, has continued to prosecute his interesting researches on the chemical constitution of plants and substances of agricultural use, the results of which are in the course of publication in the Journal of the Society. Professor Way has also favoured the Society since the last General Meeting with a lecture on the chemical character of water as connected with its agricultural uses.

The Council have decided to give Prizes for Essays on the following subjects, to be sent in by the 1st of March next:—

Farming of Shropshire	£50
Farming of Northampton . . .	50
Diseases from Mismanagement of Horses .	20
Diseases of Cattle after Parturition . .	20
Agricultural Geology of England and Wales	50
Production of Butter	10
Any subject in Agricultural Chemistry .	20

The Council have been favoured by Viscount Palmerston with important communications on the subject of the supply of Guano; and the Duke of Richmond, feeling the great importance to the farmers of this country, that so valuable a manure should if possible be supplied, not only in its genuine state, but in abundance, and at a cheap rate, has kindly undertaken, at the request of the Council, to confer with Lord Palmerston on the subject.

By order of the Council,

(Signed) JAMES HUDSON,
Secretary.

London, 14*th December*, 1850.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Half-yearly Account ending 30th June, 1850.

Receipts.	£.	s.	d.
Balance in the hands of the Bankers, 1st January, 1850	1012	17	11
Balance in the hands of the Secretary, 1st January, 1850	0	2	6
Dividends on Stock	160	6	1
Life Composition of Governor	40	0	0
Life Compositions of Members	267	0	0
Annual Subscriptions of Governors	710	0	0
Annual Subscriptions of Members	3201	1	0
Receipts on account of Journal	195	4	5
Receipts on account of Country Meetings	1471	19	0
	£7088	10	11

(Signed) C. B. CHALLONER, *Chairman*, THOS. RAYMOND BARKER, THOMAS AUSTEN, } *Finance Committee.*

Payments.	£.	s.	d.
Purchase of Stock	1217	0	0
Permanent Charges	170	12	6
Taxes and Rates	18	2	2
Establishment	635	4	3
Postage and Carriage	20	6	4
Advertisements	3	12	0
Payments on account of Journal	1415	5	8
Chemical Grant	100	0	0
Chemical Investigations	100	0	0
Prizes	248	10	6
Payments on account of Country Meetings	651	3	11
Repayment of Sums transmitted in error	18	1	0
Sundry Items of Petty Cash	5	11	8
Balance in the hands of the Bankers, 30th June, 1850	2435	3	8
Balance in the hands of the Secretary, 30th June, 1850	19	17	3
	£7088	10	11

Examined, audited, and found correct, this 13th day of December, 1850.

(Signed) THOS. KNIGHT, ROBT. BEMAN, } *Auditors on the part of the Society.*

SPECIAL COUNTRY MEETING ACCOUNT: EXETER, 1850.

Note.—The sum of £1725 as the amount of Prizes awarded by the Society in the year [illegible], is not included in this Special Account as an expense attending the Exeter Meeting, but is made chargeable in the General Account as a payment out of the common Funds of the Society.

RECEIPTS.	£.	s.	d.
Subscription from Exeter	1260	0	0
Pavilion Dinner Tickets	501	10	0
Show-yard Receipts	2576	19	4
Sale of Catalogues	323	5	0
Sale of Council Badges	6	0	0
Sale of Wheat, after trial of Implements	61	12	0
Share of Implement Shedding paid by Exhibitors	211	19	0
	£4941	5	4

PAYMENTS.	£.	s.	d.
Pavilion	540	0	0
Contract for Pavilion Dinner	442	0	0
Expenses connected with Pavilion Dinner	59	16	6
Show-yard and Trial of Implements	2610	15	2
London Police	110	2	0
Judges	366	2	6
Consulting Engineer	102	8	4
Printing, Paper, and Stitching of Catalogues	199	2	0
Printing for the general purposes of the Meeting	87	15	3
Stationery	3	3	1
Advertisements	238	9	0
Postage, Carriage, and Travelling Expenses	38	17	9
Official Staff Charges	20	4	0
Porters in Charge of Rooms	3	3	0
Council Badges	2	18	6
Non-Member's Exhibition Fee returned to a Member	1	0	0
Extra Clerks and Messengers	3	3	0
Expenses attending delivery of Lectures in Athenæum	14	3	0
Fitting Guildhall as Offices	1	10	0
Bill Posters	0	9	6
Balance carried to the credit of the General Funds of the Society	96	2	9
	£4941	5	4

(Signed) C. B. CHALLONER, *Chairman*,
THOS. RAYMOND BARKER,
THOMAS AUSTEN, } *Finance Committee.*

Country Meeting at Exeter.

PRINCIPAL DAY OF THE SHOW, THURSDAY, JULY 18, 1850.

LIST OF JUDGES.

Short Horns.	William Cox	Scotsgrove, Buckinghamshire.
	William Smith	West Rasen, Lincolnshire.
	Wm. Bartholomew	Goltho, Lincolnshire.
Devons.	Thomas Hartshorne	Silkmore House, Staffordshire.
	Emanuel Pester	Durweston, Dorsetshire.
	Thomas Townsend	Hillmorton Hall, Warwickshire.
Herefords, and other Breeds.	Henry Chamberlain	Desford, Leicestershire.
	Henry Trethewy	Grampound, Cornwall.
	John Thomas	Cholstrey, Herefordshire.
Horses.	Wm. F. Karkeek	Truro, Cornwall.
	William C. Spooner	Southampton, Hampshire.
	Charles Bowman	Greatford, Lincolnshire.
Leicester Sheep.	Valentine Barford	Foscote, Northamptonshire.
	John Hall	Wiseton, Nottinghamshire.
	William Torr	Aylesby, Lincolnshire.
South-Down Sheep.	Edward Trumper	Nuneham, Oxfordshire.
	Robert Overman	Burnham Sutton, Norfolk.
	Leonard Pitt Maton	Maddington, Wiltshire.
Long-Woolled Sheep.	Robert Beman	Moreton-in-the-Marsh, Gloucestershire.
	Edward Clarke	Canwick, Lincolnshire.
	William Gillett	Southleigh, Oxfordshire.
Pigs.	John Hannam	Kirk Deighton, Yorkshire.
	John Clayden	Littlebury, Essex.
	William Bullen	Wayford, Somersetshire.

Implements.	Charles John Carr	Belper, Derbyshire.
	William Owen	Rotherham, Yorkshire.
	William Lister	Dunsa Banks, Yorkshire.
	John Overell	Aspeden, Hertfordshire.
	Thomas Scott	Broom Close, Yorkshire.
	J. H. Nalder	Alvescot, Gloucestershire.
	Charles Paget	Ruddington Grange, Nottinghamshire.
	Thomas Hawkins	Assington Moor, Suffolk.
	Owen Wallis	Overstone Grange, Northamptonshire.
	T. P. Outhwaite	Bainesse, Catterick, Yorkshire.

Consulting Engineer—Charles Edwards Amos (of the Firm of Easton and Amos), The Grove, Southwark, Surrey.

AWARD OF PRIZES.

Cattle: I. *Short Horns.*

Henry Ambler, of Watkinson Hall, near Halifax, Yorkshire: the Prize of Forty Sovereigns, for his 5 years and 3 months-old Short-horned Bull; bred by the Earl of Carlisle, of Castle Howard, Yorkshire.

John F. P. Phillips, of Broomborough, near Totnes, Devonshire: the Prize of Twenty Sovereigns, for his 2 years and 9 months-old Short-horned Bull; bred by John Hall, of Wiseton, Nottinghamshire.

Richard Booth, of Warlaby, near Northallerton, Yorkshire: the Prize of Twenty Sovereigns, for his 1 year and 9 months-old Short-horned Bull; bred by himself.

Charles Towneley, of Towneley Park, near Burnley, Lancashire: the Prize of Ten Sovereigns, for his 1 year and 9 months-old Short-horned Bull; bred by Richard Eastwood, of Swinshow, Lancashire.

Richard Booth, of Warlaby, near Northallerton, Yorkshire: the Prize of Twenty Sovereigns, for his 5 years and 3 months-old Short-horned In-milk and In-calf Cow; bred by himself.

Richard Booth, of Warlaby, near Northallerton, Yorkshire: the Prize of Ten Sovereigns, for his 6 years and 2 months-old Short-horned In-milk and In-calf Cow; bred by himself.

Benjamin Wilson, of Brawith, near Thirsk, Yorkshire: the Prize of Twenty Sovereigns, for his 2 years and 1 month-old Short-horned In-calf Heifer; bred by himself.

John M. Hopper, of Newham Grange, near Middlesborough-on-Tees, Yorkshire: the Prize of Ten Sovereigns, for his 2 years and 8 months-old Short-horned In-calf Heifer; bred by himself.

Charles Towneley, of Towneley Park, near Burnley, Lancashire: the Prize of Ten Sovereigns, for his 1 year and 2 months-old Short-horned yearling Heifer; bred by himself.

Charles Towneley, of Towneley Park, near Burnley, Lancashire: the Prize of Five Sovereigns, for his 1 year and 9 months-old Short-horned yearling Heifer; bred by Richard Eastwood, of Swinshow, Lancashire.

Cattle: II. *Herefords.*

John Monkhouse, of the Stow, near Hereford: the Prize of Forty Sovereigns, for his 3 years and 8 months-old Hereford Bull; bred by himself.

John Walker, of Westfield House, near Hereford: the Prize of Twenty Sovereigns, for his 4 years and 3 months-old Hereford Bull; bred by himself.

William Perry, of Cholstrey, near Leominster, Herefordshire: the Prize of Twenty Sovereigns, for his 1 year, 4 months, and 29 days-old Hereford Bull; bred by himself.

James Walker, of Northleach, Gloucestershire: the Prize of Ten Sovereigns, for his 2 years and 3 months-old Hereford Bull; bred by himself.

John Nelson Carpenter, of Eardisland, near Leominster, Herefordshire: the Prize of Twenty Sovereigns, for his 6 years, 3 months, and 4 days-old Hereford In-calf Cow; bred by Philip Turner, of Leen Farm, near Pembridge, Herefordshire.

Lord Berwick, of Cronkhill, near Shrewsbury, Salop: the Prize of Twenty Sovereigns, for his 2 years and 9 months-old Hereford In-calf Heifer; bred by himself.

George Pitt, of Wellington, near Hereford: the Prize of Ten Sovereigns, for his 2 years and 5 months-old Hereford In-calf Heifer; bred by himself.

Lord Berwick, of Cronkhill, near Shrewsbury, Salop: the Prize of Ten Sovereigns, for his 1 year and 9 months-old Hereford yearling Heifer; bred by himself.

Lord Berwick, of Cronkhill, near Shrewsbury, Salop: the Prize of Five Sovereigns, for his 1 year, 7 months, and 18 days-old Hereford yearling Heifer; bred by himself.

Cattle: III. *Devons.*

George Turner, of Barton, near Exeter, Devon: the Prize of Forty Sovereigns, for his 4 years and 4 months-old pure North Devon Bull; bred by James Quartly, of Molland, Devon.

John Passmore, of Bishop's Nympton, near South Molton, Devon: the Prize of Twenty Sovereigns, for his 3 years-old North Devon Bull; bred by himself.

James Quartly, of Molland, near South Molton, Devon: the Prize of Twenty Sovereigns, for his 1 year and about 6 months-old Devon Bull; bred by himself.

John Quartly, of Champson Molland, near South Molton, Devon: the Prize of Ten Sovereigns, for his 2 years and 5 months-old Devon Bull; bred by himself.

James Quartly, of Molland, near South Molton, Devon: the Prize of Twenty Sovereigns, for his 5 years and 6 months-old North Devon In-milk Cow; bred by himself.

James Quartly, of Molland, near South Molton, Devon: the Prize of Ten Sovereigns, for his 2 years and 5 months-old North Devon In-calf Heifer; bred by himself.

James Quartly, of Molland, near South Molton, Devon: the Prize of Twenty Sovereigns, for his 8 years and 4 months-old North Devon In-milk Cow; bred by himself.

William M. Gibbs, of Bishop's Lydeard, near Taunton, Somersetshire: the Prize of Ten Sovereigns, for his 2 years and 5 months-old Devon In-calf Heifer; bred by himself.

John Quartly, of Champson Molland, near South Molton, Devon: the Prize of Ten Sovereigns, for his 1 year and 6 months-old North Devon yearling Heifer; bred by himself.

James Quartly, of Molland, near South Molton, Devon: the Prize of Five Sovereigns, for his 1 year and 6 months-old North Devon yearling Heifer; bred by John Quartly, of Molland, Devon.

Cattle: IV. *Any Breed* (not qualified to compete as Short-horns, Herefords, or Devons).

Richard H. Chapman, of Upton, near Atherstone, Warwickshire: the Prize of Twenty Sovereigns, for his 5 years and 4½ months-old pure Long-horned Bull; bred by Samuel Chapman, of Upton.

James Gorringe, of Tilton Farm, Selmeston, near Lewes, Sussex: the Prize of Ten Sovereigns, for his 4 years and 6 months-old Sussex Bull; bred by T. and S. Pix, of Peasmarsh, near Rye, Sussex.

James Gorringe, of Tilton Farm, Selmeston, near Lewes, Sussex: the Prize of Ten Sovereigns, for his 6 years and 5 months-old Sussex In-milk and In-calf Cow; bred by himself.

Nicholas Le Beir, of Castel, near St. Peter's Port, Guernsey: the Prize of Five Sovereigns, for his 7 years-old pure Guernsey In-milk Cow; bred by Sarchet, of Guernsey.

Thomas Beards, of Stowe, near Buckingham: the Prize of Ten Sovereigns, for his 2 years, 9 months, and 11 days-old Long-horned In-calf Heifer; bred by himself.

Thomas Beards, of Stowe, near Buckingham: the Prize of Five Sovereigns, for his 1 year, 10 months, and 13 days-old Long-horned yearling Heifer; bred by himself.

Horses.

Thomas Beale Browne, of Hampen, near Andoversford, Gloucestershire: the Prize of Thirty Sovereigns, for his 5 years-old Suffolk Cart Stallion; breeder unknown.

Nathaniel George Barthropp, of Cretingham Rookery, Woodbridge, Suffolk: the Prize of Fifteen Sovereigns, for his 9 years-old Suffolk Cart Stallion; bred by Samuel Wrinch, of Great Holland, Essex.

Frederick Thomas Bryan, of Knossington, near Oakham, Rutlandshire: the Prize of Twenty Sovereigns, for his 2 years-old Cart Stallion; bred by John Wild, of Tollerton, Nottinghamshire.

David Wright, of Hepworth, near Ixworth, Suffolk: the Prize of Ten Sovereigns, for his 2 years-old Suffolk Cart Stallion; bred by himself.

Charles Poulton, of No. 7, Sydney Terrace, Reading, Berkshire: the Prize of Fifteen Sovereigns, for his aged Roadster Stallion; bred by Mr. Slater, near Lincoln.

John Ward, of East Mersea, near Colchester, Essex: the Prize of Twenty Sovereigns, for his Cart Mare and Foal; the mare bred by himself; sire of foal belonged to himself.

Nathaniel George Barthropp, of Cretingham Rookery, near Woodbridge, Suffolk: the Prize of Ten Sovereigns, for his Cart Mare and Foal, the mare bred by himself; sire of foal belonged to himself.

Nathaniel George Barthropp, of Cretingham Rookery, near Woodbridge, Suffolk: the Prize of Fifteen Sovereigns, for his 2 years-old Filly; bred by Robert Seace, of Laxfield, Suffolk.

William Fisher Hobbs, of Boxted Lodge, near Colchester, Essex: the Prize of Five Sovereigns, for his 2 years-old Filly; bred by himself.

Sheep: I. *Leicesters.*

William Abraham, of Barnetby-le-Wold, near Brigg, Lincolnshire: the Prize of Thirty Sovereigns, for his 16 months-old Leicester Ram; bred by himself.

William Sanday, of Holme Pierrepoint, near Nottingham: the Prize of Fifteen Sovereigns, for his 16 months-old Leicester Ram; bred by himself.

*Thomas Miller, of Castle Farm, Dorset: a pure Devon Bull; bred by Mr. Bouchier, of Wiveliscombe.

Thomas Bond, of Bishop's Lydeard: a Devon Bull; bred by Mr. Duckham, of Bishop's Lydeard.

Thomas Bodley, of Stockley Pomeroy, Devon: a North Devon Bull; bred by himself.

Samuel Farthing, of Nether Stowey: a Devon Bull; bred by himself.

William Hole, of Hannaford, Devon: a Devon Bull; bred by himself.

John Ley, of Trehill: a North Devon Bull; bred by Richard Merson, of Brinsworthy.

The Earl of Leicester, of Holkham Hall: a Devon Bull; bred by himself.

John Lutley, of Wiveliscombe: a Devon Bull; bred by himself.

**Thomas B. Morle, of Park Farm, Somerset: a Devon Bull; bred by John Quartly, of Molland.

Richard Merson, of North Molton: a Devon Bull; bred by himself.

Henry Manning, of Stone, Devon: a pure North Devon Bull; bred by Richard Merson, of Brinsworthy.

William Northey, of Lake Lifton: a Devon Bull; bred by John Quartly, of Molland.

The Hon. D. Pelham, M.P., of St. Lawrence: a North Devon Bull; bred by himself.

James Quartly, of Molland: a Devon Bull; bred by himself.

James Risdon, of Hartleigh, Devon: a Devon Bull; bred by George Turner, of Barton.

William Stone, of Clayford, Somerset: a Devon Bull; bred by himself.

John A. Thomas, of Rose Ash, Devon: a Devon Bull; bred by himself.

George Turner, of Barton: a Devon Bull; bred by James Quartly, of Molland.

**James Quartly, of Molland: a North Devon in-Milk Cow; bred by John Quartly, of Molland.

**John Knight Farthing, of Nether Stowey, Somerset: a pure Devon in-Calf Heifer: bred by himself.

**James Quartly, of Molland: a North Devon in-Calf Heifer; bred by himself.

**James W. Buller, of Downes: two North Devon Yearling Heifers; bred by himself.

**John Blomfield, jun., of Warham, Norfolk: 2 true North Devon Yearling Heifers; bred by himself.

**John Tanner Davy, of Rose Ash: a pure North Devon Yearling Heifer; bred by Mr. Quartly, of Molland.

**John Tanner Davy, of Rose Ash: a pure North Devon Yearling Heifer; bred by himself.

**James Davy, of Flitton Barton: a pure Devon Yearling Heifer; bred by himself.

**Samuel Farthing, of Nether Stowey: a pure Devon Yearling Heifer; bred by himself.

**Charles Gibbs, of Bishop's Lydeard: a Devon Yearling Heifer; bred by himself.

**James Hole, of Knowle House, Somerset; 2 pure Devon Yearling Heifers; bred by himself.

**The Earl of Leicester, of Holkham Hall: 2 North Devon Yearling Heifers; bred by himself.

**John Lutley, of Wiveliscombe: a Devon Yearling Heifer; bred by himself.

**J. Davy Palmer, of Yeat, Cornwall: a North Devon Yearling Heifer; bred by himself.

**The Hon. D. Pelham, M.P., of St. Lawrence: a North Devon Yearling Heifer; bred by himself.

**George Turner, of Barton: a pure North Devon Yearling Heifer; bred by himself.

**George Turner, of Barton: a pure North Devon Yearling Heifer; bred by Richard Mogridge, of Molland.

**John A. Thomas, of Rose Ash: a Devon Yearling Heifer; bred by himself.

CLASS

2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

 [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . Five Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

Channel Islands' Breed.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

 [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . Five Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

Sussex Breed.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

 [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . Five Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

Scotch horned Cattle.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . Ten Sovereigns.

CLASS

3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

   [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Ten Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

Scotch polled Cattle.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

   [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Ten Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

Welsh, Irish, and other pure Breeds.

1. To the owner of the best Bull calved previously to the 1st of January, 1849 . Ten Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1849, and more than one year old . . . . . . Ten Sovereigns.
3. To the owner of the best Cow in milk or in calf . . . . Ten Sovereigns.

   [In the case of the cow, to which this prize is awarded, being in calf, and not in milk, the prize will not be given until she is certified to have produced a live calf.]

4. To the owner of the best in-calf Heifer, not exceeding three years old . . . Five Sovereigns.
5. To the owner of the best Yearling Heifer . Five Sovereigns.

HORSES.

1. To the owner of the best Stallion for Agricultural Purposes, of any age . . . Thirty Sovereigns.
   To the owner of the second-best ditto ditto . Fifteen Sovereigns.
2. To the owner of the best two years-old Stallion for Agricultural Purposes . . Twenty Sovereigns.

CLASS

To the owner of the second-best ditto ditto . Fifteen Sovereigns.
To the owner of the third-best ditto ditto . Ten Sovereigns.

3. To the owner of the best Stallion for Dray Purposes . . . . Twenty Sovereigns.
4. To the owner of the best Stallion for getting Hunters . . . . Thirty Sovereigns.
5. To the owner of the best Stallion for getting Carriage Horses . . . . . Thirty Sovereigns.
6. To the owner of the best Stallion for getting Roadsters . . . . . . Fifteen Sovereigns.
7. To the owner of the best Mare and Foal for Agricultural Purposes . . . Twenty Sovereigns.
   To the owner of the second-best ditto ditto . Fifteen Sovereigns.
   To the owner of the third-best ditto ditto . Ten Sovereigns.
8. To the owner of the best two years-old Filly for Agricultural Purposes . . . Twenty Sovereigns.
   To the owner of the second-best ditto ditto . Fifteen Sovereigns.
   To the owner of the third-best ditto ditto . Five Sovereigns.

SHEEP.

Leicesters.

1. To the owner of the best Shearling Ram . Thirty-five Sovs.
   To the owner of the second-best ditto . . Twenty Sovereigns.
   To the owner of the third-best ditto . . Ten Sovereigns.
2. To the owner of the best Ram of any other age . . . . Thirty Sovereigns.
   To the owner of the second-best ditto . . Twenty Sovereigns.
   To the owner of the third-best ditto . . Ten Sovereigns.
3. To the owner of the best pen of Five Shearling Ewes of the same flock . . . Twenty Sovereigns.
   To the owner of the second-best ditto ditto . Fifteen Sovereigns.
   To the owner of the third-best ditto ditto . Ten Sovereigns.

South-Down, or other Short-woolled Sheep.

1. To the owner of the best Shearling Ram . Thirty-five Sovs.
   To the owner of the second-best ditto . . Twenty Sovereigns.
   To the owner of the third-best ditto . . Ten Sovereigns.
2. To the owner of the best Ram of any other age . . . . Thirty Sovereigns.
   To the owner of the second-best ditto . . Twenty Sovereigns.
   To the owner of the third-best ditto . . Ten Sovereigns.
3. To the owner of the best pen of Five Shearling Ewes of the same flock . . . Twenty Sovereigns.
   To the owner of the second-best ditto ditto . Fifteen Sovereigns.
   To the owner of the third-best ditto ditto . Ten Sovereigns.

Long-woolled Sheep:

Not qualified to compete as Leicesters.

CLASS		
1.	To the owner of the best Shearling Ram .	Twenty-five Sovs.
	To the owner of the second-best ditto . .	Fifteen Sovereigns.
2.	To the owner of the best Ram of any other age	Twenty Sovereigns.
	To the owner of the seeond-best ditto . .	Ten Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes of the same floek . . .	Ten Sovereigns.
	To the owner of the seeond-best ditto . .	Five Sovereigns.

Sheep best adapted to a Mountain District:

Not qualified to compete as South-downs.

1.	To the owner of the best Ram of any age .	Twenty Sovereigns.
	To the owner of the second-best ditto . .	Ten Sovereigns.
2.	To the owner of the best pen of Five Shearling Ewes	Ten Sovereigns.
3.	To the owner of the best pen of Ewes of any age	Ten Sovereigns.

PIGS.

1.	To the owner of the best Boar of a large breed	Fifteen Sovereigns.
	To the owner of the second-best ditto ditto .	Ten Sovcreigns.
	To the owner of the third-best ditto ditto .	Five Sovereigns.
2.	To the owner of the best Boar of a small breed	Fifteen Sovereigns.
	To the owner of the second-best ditto ditto .	Ten Sovereigns.
	To the owner of the third-best ditto ditto .	Five Sovereigns.
3.	To the owner of the best Breeding Sow of a large breed	Fifteen Sovereigns.
	To the owner of the seeond-best ditto ditto .	Five Sovereigns.
4.	To the owner of the best Breeding Sow of a small breed	Fifteen Sovereigns.
	To the owner of the seeond-best ditto ditto .	Five Sovereigns.
5.	To the owner of the best pen of three Breeding Sow-Pigs of a large breed, of the same litter, above four and under eight months old	Ten Sovereigus.
	To the owner of the second-best ditto ditto .	Five Sovereigns.
6.	To the owner of the best pen of three Breeding Sow-Pigs of a small breed, of the same litter, above four and under eight months old	Ten Sovereigns.
	To the owner of the sceond-best ditto ditto .	Five Sovereigns.

By order of the Council,

James Hudson, *Secretary.*

London, December 12, 1850.

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